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ABSTRACT

Based on the philosophical statements and directions developed by the Jackson's Mill Project (Charleston, West Virginia, 1981) this operational guide was developed to provide local or state curriculum designers with methods of implementation. Content and suggested activities for various technology-related courses are provided, along with models for implementing the courses in small, medium, and large schools. The 10 sections of the guide cover the following topics: a rationale and mission for industrial arts/technology education; structuring industrial arts/technology education programs; structuring courses; introductory foundation course structure; manufacturing course structures; communication course structures; construction course structures; transportation course structures; synthesis course structures; and initiating and implementing new and improved programs. The course structures sections list course title, description, and objectives; grade level; and content with representative activities and time allocations. Appendixes to the guide include content-area taxonomies, a base for curriculum derivation, and a model of the human productive activity cycle. (KC)

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INDUSTRIAL ARTS/TECHNOLOGY EDUCATION

A guide for developing contemporary industrial arts/technology education curricula

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SUGGESTED CONTENT FOR EXPLORING TECHNOLOGY AND CONTEMPORARY TECHNOLOGY

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PREFACE

There is a growing movement throughout the nation on the part of educators to strive for excellence in teaching youth about industry and technology. Several new curriculum ventures, such as The Standards for Industrial Arts, the Jackson's Mill Industrial Arts Curriculum Theory, and the Symposium Series on Technology Education, have served as valuable resources for program development. However, none of these were designed to provide the curriculum planner with an operational level guide. This project, funded by the Technical Foundation of America, was an attempt to synthesize the ideas from these and other materials, and to provide the local or state curriculum designer with an implementation guide.

The project participants agreed to accept the basic philosophical statements and directions developed by the Jackson's Mill Project (Appendix A). Also, the definitions of basic terms developed by the Jackson's Mill participants were judged to be appropriate for the project. These definitions were:

> Technology Education is a comprehensive educational program concerned with technology--its evolution, utilization, and significance; with industry--its organization, personnel, systems, techniques, resources, and products; and the social/cultural impact of technology and industry.

> Technology is considered as the knowledge and study of human endeavors in creating and using tools, techniques, resources, and systems to manage the man-made and natural environments for the purposes of extending human potential and the relationship of these to individuals, society, and the civilization.

Industry is considered that part of the societal economic institution that uses resources to produce goods, services, and information to meet the needs and wants of individuals and society.

Finally, an emphasis on the inputs, processes, outputs, and societal context of the four major human productive activities--communication, construction, manufacturing, transportation--was accepted as the proper thrust for contemporary industrial arts/technology education.

With these assumptions, the participants of the Industry and Technology Education Project undertook the task of developing:

1. taxonomies for each content area (Appendix C)
2. program structures for various sized schools, and
3. basic outlines for each course in each suggested program.

INTRODUCTION

INDUSTRIAL ARTS/TECHNOLOGY EDUCATION
A Rationale and Mission Statement

The world has changed more in the past two hundred years than it has throughout all previous history. The rate of change is continuing at an ever-accelerating pace and is of an increasing magnitude.

Technology has done more to change the way we live than all other forces. Much of this technology is organized as a productive unit called industry. While science has made enormous contributions by providing us with "truth" or what is," technology has made its impact by providing us with "know how" or a knowledge of efficient and appropriate action. While technology is as old as the earliest artifacts that have left their historic trail, it has been moving ahead with prodigious and startling advances. Today science and technology are moving ahead in a parallel path. Each feeds the other and enables more advances as problems of our era are creatively solved.

Prior to the industrial revolution our level of technology was simple, yet useful for its time. People during this agrarian and cottage industry era were able to observe the technology around them on a first-hand basis. This personal observation was possible because the cooper, iron worker, saddlemaker, and wheelwright often worked in the open and people were able to interact with them. The industrial revolution subdivided the production of products into specialized tasks and isolated the worker from public view. The factory, the office, and the construction site separated productive activity from the public and, therefore, new technical developments became "mysterious."

We are rapidly moving from what is often referred to as a time of "old industry" (typified by people working at assembly lines in factories) to an information age. Dominant in the "new industry" are the technological developments of computers, lasers, robots, computer-aided design and

computer-aided manufacture (CAD/CAM), new materials, new processes, new techniques and communication systems. A new emphasis is being placed on productivity, efficiency, conservation, and quality as compared to the past quest for quantity.

As technological development continues at an accelerating rate, it will become increasingly difficult for people to understand these changes. Something must be done to prevent us from becoming a technologically illiterate nation. It is absolutely necessary for all people to understand technology if they are to function as citizens in their roles of voters, workers, employers, and family members. A concentrated effort is essential to educate the citizens of our nation to better understand technology and its impact.

Therefore, THE MISSION OF EDUCATORS IN OUR PROFESSION IS TO INCREASE EACH PERSON'S ABILITY TO COMPREHEND AND APPLY THE CONCEPTS OF INDUSTRIAL ARTS/TECHNOLOGY EDUCATION SYSTEMS.

The study of technology should result in people who (1) adjust to the changing environment, (2) deal with forces that influence the future, and (3) eagerly participate in controlling their own destiny.

Technology education will produce individuals who can participate and adapt to a dynamic technological society. Consistent with their abilities, interests, and needs, learners will:

1. appreciate the evolution of technology;
2. establish values on the impact of technology and how it alters our environment;
3. develop knowledge and ability to properly use the tools, techniques, and resources of technological systems;
4. develop creative solutions to present and future societal problems using technical means;
5. develop human potentials for responsible work, leisure, and citizenship roles in a technological society.

STRUCTURING TECHNOLOGY EDUCATION PROGRAMS

The Industry and Technology Education Project participants accepted the Jackson's Mill Project philosophy as contained in Appendix A and developed content structures and taxonomies for the four technological systems (communication, construction, manufacturing, and transportation). Using this work as a basis, program structures were developed using the following assumptions:

1. All students need a basic foundation of knowledge and experience about technology and its societal context.
2. The foundation must include broad introductory experiences which present the interface among research and development, technological systems, service, use, and personal-corporate management interaction. (See Appendix B.)
3. The program must include specific experiences in each of four technological systems--communication, construction, manufacturing, and transportation.
4. The experiences in the technological systems should include both the productive and the management activities of the system.
5. the technological systems are best understood if examples are provided of the design of the product or system and the productive activity within the systems.
6. The enrollment of the industrial arts/technology education program will determine the number and variety of courses that can be offered.
7. Synthesis courses in research and development and in enterprise should be included in the program of any school.
8. Prerequisites should be minimized to encourage flexibility in student enrollment.
9. All courses should use practical laboratory activities to enhance fundamental conceptual development.

10. Experiences about the technological systems should be integrated into the elementary school curriculum.

Using these assumptions as guidelines, a series of three model program structures are developed to accommodate industrial arts/technology education programs of difference sizes. The following charts present these program structures. Each program structure has five common elements:

1. Integrated Technology

   These are a series of locally developed units which integrate concepts about industry and technology into the existing elementary school curriculum. The taxonomies in Appendix C provide content for these units.

2. Introduction to Technology Systems

   The first formal course offerings in technology education. Two courses--Exploring Technology, Contemporary Technology--provide a comprehensive introduction of technology in all four technological adaptative systems (communications, construction, manufacturing, transportation). The introduction allows consideration of the development of technology from the development of technology from past, present and future perspective.

3. Communication Systems; Construction Systems; Manufacturing Systems; Transportation Systems

   Four courses which provide separate introductions to each of the four industrial and technological systems.

4. Industrial Enterprise

   A synthesis course which emphasizes the managed system required to manufacture a product, construct a structure, communicate a message, or transport people or goods.

5. Research and Development

A synthesis course designed for individuals or groups to pursue new knowledge or project solutions for a technological problems.

Note: These common courses could constitute an adequate industrial arts/technology education program for a school with limited enrollment.

Schools with large enrollments can add more specialized courses in each of the technological systems. These courses are show as Level IV in the charts that follow this discussion.

The charts are listed for (1) small, (2) medium, and (3) large programs. For this project these three sizes of programs were defined as follows:

Small Program

Typically, this program would have one or two technology education teacher(s) and an industrial arts/technology education enrollment under 160 students at any one time.

Medium Program

Typically, this size program would have two or three technology education teachers and an industrial arts/technology arts enrollment between 160 and 300 students at any one time.

Large Program

Typically, large programs would have at least four industrial arts/technology education teachers and over 320 students enrolled at any one time.

SMALL PROGRAM MODEL

LEVEL I
(Grades K-6)

INTEGRATED TECHNOLOGY

LEVEL II
(Grades 7-8)

INTRODUCTION TO TECHNOLOGY

EXPLORING TECHNOLOGY

CONTEMPORARY TECHNOLOGY

LEVEL III
(Grades 9-10)

COMMUNICATION SYSTEMS

CONSTRUCTION SYSTEMS

MANUFACTURING SYSTEMS

TRANSPORTATION SYSTEMS

LEVEL IV
(Grades 11-12)

MEDIA COMMUNICATIONS SYSTEMS

STRUCTURES AND SYSTEMS

MANUFACTURING MATERIALS AND PROCESSES

TECHNICAL ELEMENTS TRANSPORTATION

RESEARCH AND DEVELOPMENT

ENTERPRISE

MEDIUM PROGRAM MODEL

LEVEL I
(Grades K-6)

INTEGRATED TECHNOLOGY

LEVEL II
(Grades 7-8)

INTRODUCTION TO TECHNOLOGY

EXPLORING TECHNOLOGY

CONTEMPORARY TECHNOLOGY

LEVEL III
(Grades 9-10)

COMMUNICATION SYSTEMS

CONSTRUCTION SYSTEMS

MANUFACTURING SYSTEMS

TRANSPORTATION SYSTEMS

LEVEL IV
(Grades 11-12)

GRAPHIC COMMUNICATION SYSTEMS

ELECTRONIC COMMUNICATION SYSTEMS

STRUCTURES AND SYSTEMS

CONSTRUCTION PLANNING AND DESIGN

MANUFACTURING MATERIALS AND PROCESSES

PRODUCT AND PRODUCTION SYSTEM DESIGN

TECHNICAL ELEMENTS TRANSPORTATION

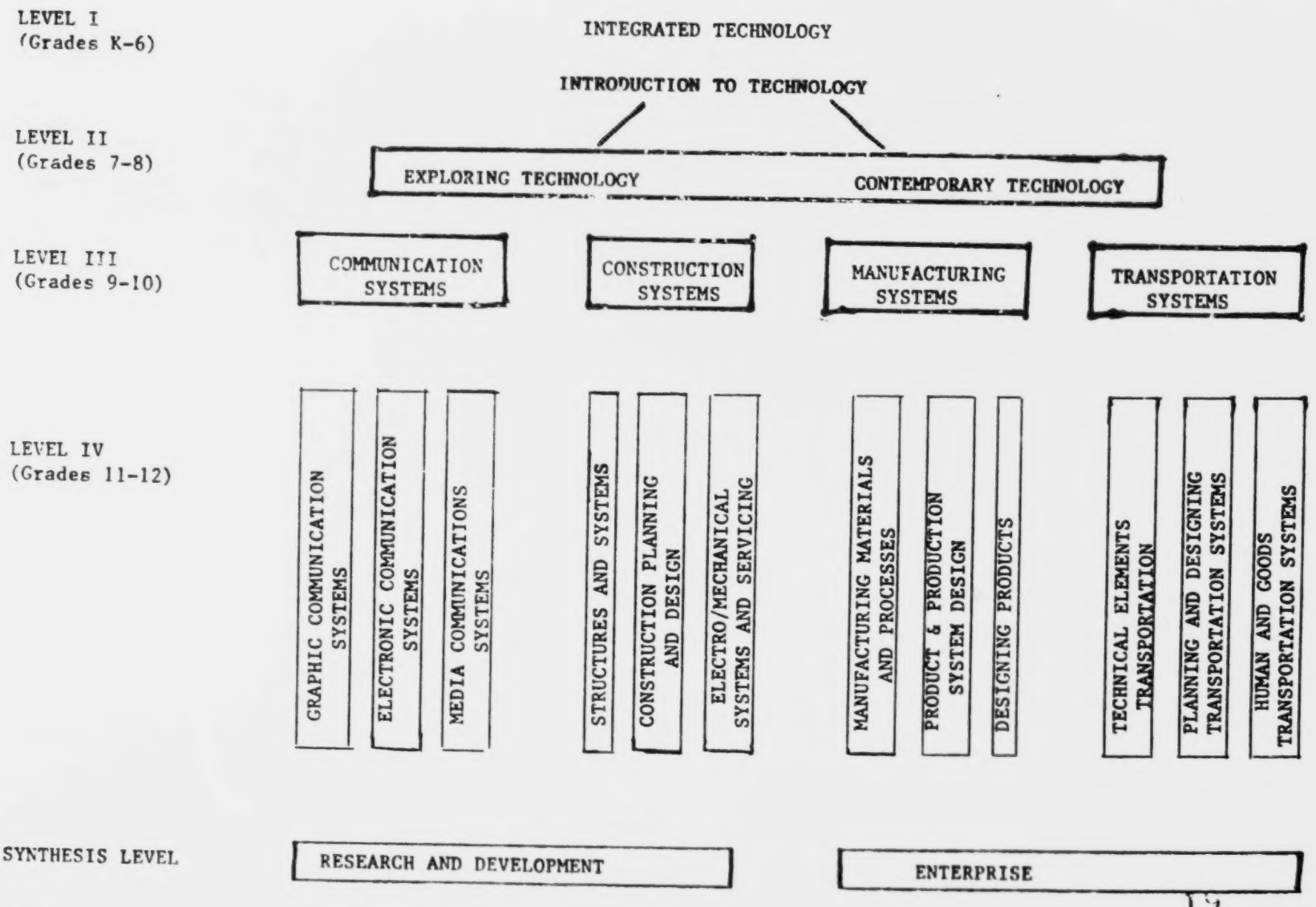
HUMAN AND GOODS TRANSPORTATION SYSTEMS

SYNTHESIS LEVEL

RESEARCH AND DEVELOPMENT

ENTERPRISE

LARGE PROGRAM MODEL



COURSE STRUCTURES

STRUCTURING THE COURSES

The structuring of programs is only part of the task of arranging content for delivery. The identified courses must be developed. Their content must be selected from the taxonomies. Activities which are interesting and meaningful must be selected. Then, the courses must be divided into units to insure that a balanced emphasis on the several concepts is being maintained.

The following structures for all the courses listed in the three school-size program models contain the three elements listed above. If any of the courses are to be offered for a different length of time, care must be exercised to maintain the balance between units.

INTRODUCTION TO TECHNOLOGY

EXPLORING TECHNOLOGY

CONTEMPORARY TECHNOLOGY

COMMUNICATIONS SYSTEM	CONSTRUCTION SYSTEM	MANUFACTURING SYSTEM	TRANSPORTATION SYSTEM

COURSE TITLE

"Exploring Technology" (8108) 18 weeks/36 weeks
Grade 7

(Level II -- All Schools)

COURSE DESCRIPTION

This course is a study of the evolution of technological development from past to present and its impact on the social/cultural environment. Utilizing laboratory tools and a variety of materials, students will design, construct, and demonstrate models of technological inventions or events having major impact on man and his environment. Further, students will identify scientific and mathematical principles used in the invention and describe its function in modern society. Individual and small group activities will provide the forum for the integration of the basic communications skills of research, oral, and written reporting. Models selected from the technological systems of communications, construction, manufacturing, and transportation will provide students with an awareness of their own interests and abilities, thus beginning the process of isolating possible career options.

COURSE OBJECTIVES:

At the completion of this course, the student will be able to:

1. Understand the development of tools, materials and processes into systems of Technology as they apply to Communication, Construction Manufacturing and Transportation.

2. Understand and apply the research and development process.

3. Understand and appreciate the relationship between technology and the individual's quality of life.

4. Understand the role of competent and responsible technologically literate people as they carry out their daily functions as an informed consumer, user and citizen.

COURSE TITLE

"Contemporary Technology" (8118) 18 weeks/36 weeks
Grade 8

(Level II -- All Schools)

COURSE DESCRIPTION

This course develops and understanding of the current concepts and principles associated with modern industry and technology. It emphasizes a contemporary and future orientation in an effort to provide a relevant and meaningful introduction to the study of industry and technology and the impact that they have upon society. Mathematics and scientific principles that related to student activities in the technological systems of communications, construction, manufacturing, and transportation are emphasized. Basic communications skills are integrated throughout the course. Student interests, special abilities, and potential career paths are identified in the course.

COURSE OBJECTIVES:

At the completion of this course the student will be able to:

1. Understand and use the sytems of contemporary technology as they apply to Communication, Construction, Manufacturing and Transportation.

   a. apply the universal inputs of systems. (i.e. finances, personnel, energy, capital, etc.)

   b. apply the productive processes of the identified sytems.

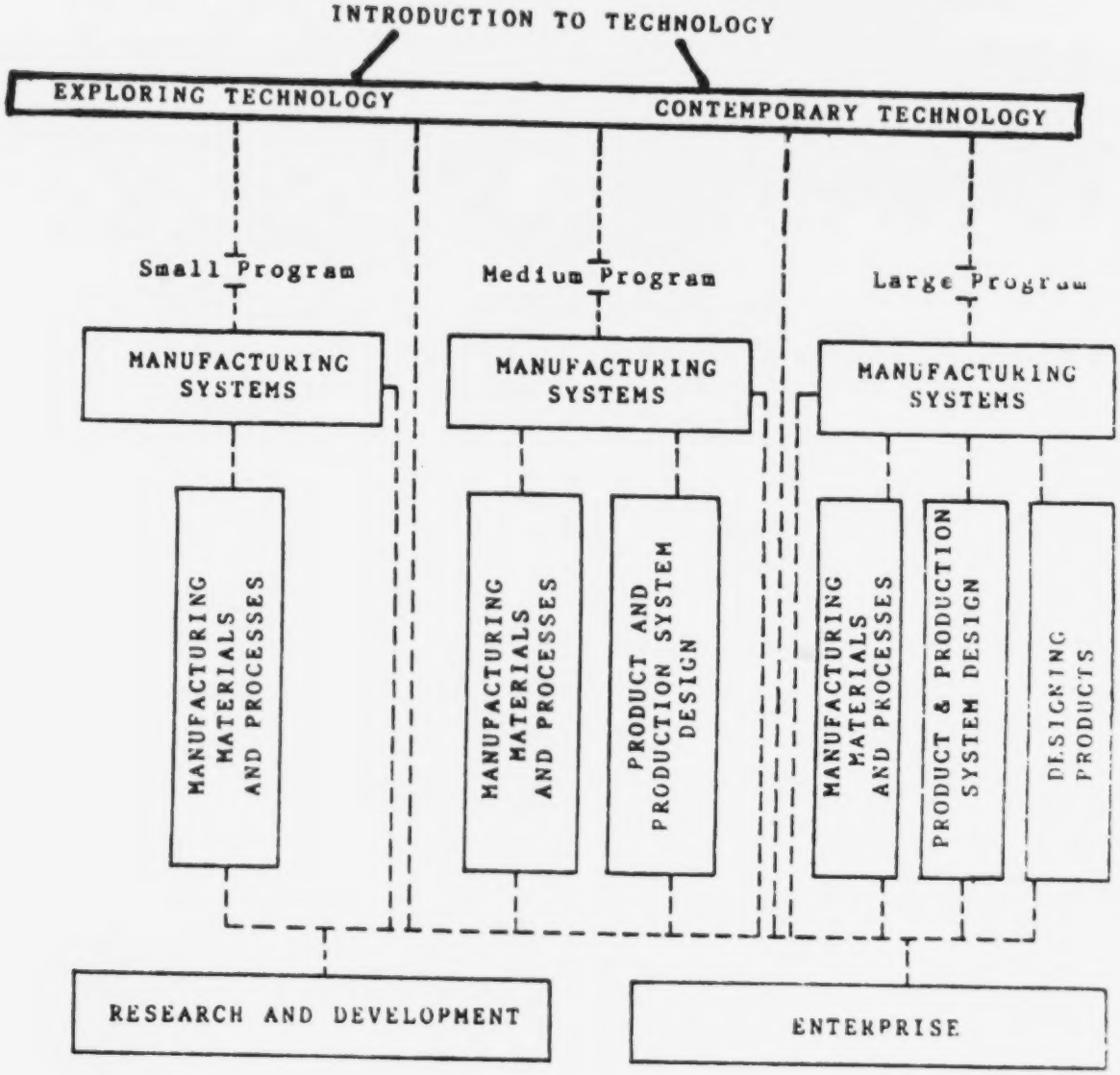
   c. manage the "systems."

2. Understand and apply the research and development to develop a new product or use a procedure in a new way.

3. Understand the role of competent and responsible technologically literate people as they carry out their daily functions as an informed consumer, user and citizen.

MANUFACTURING COURSES

*(INTEGRATED TECHNOLOGY)



*NOTE: WHILE THIS IS A PART OF THE SCOPE FOR INDUSTRIAL ARTS/ TECHNOLOGY EDUCATION, EXPENDITURES FROM VOCATIONAL FUNDS ARE RESTRICTED TO GRADES 7 - 12.

INTRODUCTION TO MANUFACTURING

Manufacturing is a technical adaptive system designed by people to efficiently utilize resources to extract and convert raw/recycled materials into industrial standard stock and then into industrial and consumer goods. While there may not be one perfect manufacturing curricula, all manufacturing curriculum that are broad based and complete will include three central themes. These are as follows:

1. a study of material processing,
2. a study of managed production activities and
3. a study of the manufacturing enterprise.

The manufacturing course structure that follows incorporates these themes into three general program organizational patterns: small, medium and large.

Looking at the large program model first, the full range of courses is evident. Starting at Level IV, the Manufacturing Systems course combines material processing and management components in a general framework to provide students with an introduction to the Manufacturing cluster. The systems course emphasizes the development of a conceptual understanding of the secondary material processes (casting/molding, forming, separating, conditioning, assembling and finishing) in conjunction with the managed sequence of activities used to convert an idea into a functional manufactured product.

The second course in the sequence is Manufacturing Materials and Processes. Here students are introduced to and provided with experiences in (1) the properties of

industrial materials, (2) the production of standard stock, and (3) the transformation of standard stock into finished products. The emphasis is on the development of basic concepts common to all processes as they relate to polymeric, metallic and ceramic materials.

The two remaining courses identified in the large program model provide greater depth in specific manufacturing areas that are introduced in preceding courses. These areas are:

1. designing, developing and engineering products to meet the needs and wants of consumers, and
2. designing and developing production systems.

Using the experience and knowledge gained from the Manufacturing Systems course and the Manufacturing Materials and Processes course (as well as that from Math, Science and other Technology Education courses), the student is provided and opportunity to explore in more detail specific areas of manufacturing. The course, Designing Products for Manufacture, emphasizes an activity-centered study of the tasks associated with design problem identification and conceptualization, design review, product design interpretation and specification, and product testing. Manufacturing Production Systems emphasizes efficient and appropriate plant layouts, process selection and sequencing, materials handling system design, quality control procedures, production planning and control activities, work measurement practices, and product manufacture.

Looking at the large program structure for Manufacturing, the sequence of courses proceeds from the broad, general introduction at Level II to the more specific experiences in Level III and IV. It is the intent of the authors that all students interested in Manufacturing take at least the Manufacturing Systems course and the

Manufacturing Materials and Processes course. The Product Design course and the Production Systems course provide opportunities for advanced study, as well as the R&D and Enterprise courses found in the Synthesis level of the model. Students should not be required to take all of the Level IV courses before moving to the Synthesis level. Some students may move from Level III through the Materials and Processes course, directly into the R&D and/or the Enterprise course(s).

When comparing the large program model and courses to the medium and small program models, the reader will see where the content and activities for product design and production systems have been condensed into one course in the medium program model. The Materials and Processes course remains intact across all three program models. Due to the limitations of resources and staff in the small program model, the Product Design and Production Systems course has been deleted. This has been done to maintain a sequence of courses ranging from the General Systems courses to the Materials and Processes course, and concluding with the Synthesis courses, which may be general or specific in nature.

When reviewing the program models, it is important to keep in mind that course content must be presented through activity-based methodologies. The primary goal for any of the three program models should be to provide a broad picture of materials, rather than develop specific manipulative skills. This broad picture should be developed in conjunction with the managed sequence of activities used in the Manufacturing area to convert an idea into a product.

COURSE TITLE

"Manufacturing Systems" (8115) 18 weeks

(Level III All school sizes) Grades 9-10

*ALSO SEE LARGE SCHOOL (8115)

COURSE DESCRIPTION

The manufacturing systems course provides students with a general introduction to the material processing and management components of a manufacturing activity. Emphasis is placed on the development of a conceptual understanding of (1) the six families of secondary material processes and (2) the managed sequence of activities used to convert a designer's ideas into a product which is produced and converted into money in the marketplace.

COURSE OBJECTIVES:

The course is designed to provide students with the opportunity to develop an ability to:

1. Understand the major processes used to change raw materials into industrial goods and industrial goods into products.
2. Complete some common secondary material processing activities.
3. Understand manufacturing as it is related to the larger context of technology, industry, and society.
4. Understand the managed activities used to design, specify, manufacture, and market manufactured goods.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Introduction to manufacturing - Manufacturing and society * Societal institutions * Impacts - Manufacturing enterprises - Manufacturing systems * Inputs * Processes - Material processing - Management * Outputs	Students should operate a line production which the teacher has developed or which has been developed by a previous class. View Society of Manufacturing Engineer's film "The Challenge of Manufacturing available from the Modern Talking Pictures Service (Free)	5%
Introduction to material processing - Classes of processes * Primary * Secondary - Process outputs * Industrial goods * Consumer goods * Military goods * Ancillary - Scrap/Waste - Pollutants	FILM: select a film or video tape which shows the production of industrial goods from raw materials and/or the production of products from industrial goods. Emphasize classes of processes and outputs. Show examples of slides of industrial goods/ finished products. Discuss processes used to produce items. Discuss, through slides and examples, the types of materials produced by primary processes (ceramic, metallic, polymeric--wood and plastic) and their properties.	2%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Primary manufacturing processes * thermal * chemical * mechanical * electrical		
Secondary processing - Casting and molding * preparing molds * preparing materials * introducing materialds into molds * solidifying materials * extracting materials from molds	Students should produce selected cast or molded parts or products using a variety of materials and processes. Not all students need to complete the same number of castings or use the same materials or processes. During the review differing experiences among the students can be discussed and summarized.	8%
- Forming * selecting shaping devices * determining temperatures * applying pressure	Students should produce selected formed parts or products using a variety of materials and forming processes.	5%
- Separating * selecting cutting elements * establishing cutting and feed motions * clamping work and cutting elements	Students should produce selected machined or sheared parts or products using a variety of materials and separating processes.	15%
- Conditioning materials * chemical conditioning	Students should condition parts or products they produced by casting or molding, forming or separating.	3%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
* Thermal conditioning * Mechanical conditioning - Assembling * Bonding * Fastening materials - Finishing * Selecting finishes * Preparing materials for finishing * Applying finishes * Curing finishes	Students should bond and mechanically fasten parts produced by casting, molding, forming, or separating to produce subassemblies and/or products. Students should apply finish to previously produced parts, subassemblies and products.	5% 5%
Introduction to management - Functions of management * Planning * Organizing * Actuating * Controlling - Types of managed systems * Custom * Intermittent - Job lot - Batch * Continuous	Film, filmstrip, field trip or speaker which presents to movement of a designer's idea through specifications to manufacture and marketing	1%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Managed Activities - Establishing the organization * Structuring the organization * Employing managerial personnel		
- Designing the product * Research * Development * Product engineering	Introduce research and development have students - sketch product ideas for assigned design problems - Refine ideas - build soft (styrofoam, cardboard) mock-ups - survey the market to determine customer acceptance of the product and identify competition	14%
- Preparing to produce the product * Manufacturing engineering * Production planning & control * Employing production and personnel * Training production personnel * Purchasing production materials * Preparing to control quality	For the designed product, students should - select and sequence operations - design and construct tooling - prepare plant layout and material handling system - determine employee and material needs - establish a quality control system - become employed and trained for a production job - pilot test the production line	18%
- Producing the product * Processing materials * Controlling quality * Establishing safety programs * Administering wage programs	During the production of the product the students should - produce parts, subassemblies and products - operate the quality control system - discuss and establish a safety program - consider the need for a labor union - maintain wage records	7%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
* establishing safety programs * administer wage programs - Marketing the product * advertising * sales * distribution	- operate the quality control system - discuss and establish a safety program - consider the need for a labor union - maintain wage records The students should: - design product advertising - develop and operate a sales program - design and produce a product package	8%
Evolution of manufacturing - Historical milestones - Present-day manufacturing * practices * societal impacts * personal interaction - career roles - consumer roles - citizen/voter roles - Future trends * employment/jobs * resource utilization * computerization * etc.	Show one or two episodes of the "Connection" series video tapes Student panel discussion on: - my role as a worker - preservation of the environment vs need for natural resources - industry and the consumer * quality of products * price * performance * etc. - Training and education for employment	2%

COURSE TITLE

"Manufacturing Materials and Processes" (8165) 18 weeks

(Level IV All school sizes) Grade 11-12

COURSE DESCRIPTION

The Manufacturing Materials and Processes course provides students with an introduction to (1) the properties of industrial materials, (2) production of standard stock and (3) the transformation of standard stock into finished products. The emphasis of the course is on introductory concepts common to all processes as they relate to polymeric, metallic and ceramic materials. The content is presented through activity-based methodologies. The goal is to provide a broad picture of materials and processes rather than develop specific manipulative skills. Therefore, care should be given to provide a balanced emphasis between primary and secondary processing and among the six families of secondary processes.

COURSE OBJECTIVES:

Upon completion of the course, students should be able to:

1. Relate material properties and processing activities to the larger context of industry and technology.
2. Differentiate between primary and secondary material processing activities.
3. Describe the six major types of secondary material processing activities.
4. Perform selected primary and secondary material processing activities.

COURSE OBJECTIVES (continued)

5. Describe the major properties of materials.
6. Perform selected tests to determine materials properties.
7. Exhibit safe work habits and cooperative attitudes.
8. Select alternate materials that will meet product and consumer requirements.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
* Introducing materials into molds * Solidifying materials * Extracting castings or molded products	- both gravity and pressure techniques for introducing materials into molds.	
- Forming * Selecting shaping devices * Determining material temperature * Applying pressure	Form several products or parts of products using - metallic, polymeric and ceramic materials - one-piece and mated dies and/or smooth or mated rolls	10%
- Separating * Selecting cutting elements * Establishing cutting and feed motion * Clamping work and cutting elements	Machine, shear, and/or flame cut materials to produce parts or products. Include as many combinations as possible of cutting elements, feed and cutting motions, and work and tool holding systems.	18%
- Conditioning materials * Chemical conditioning * Thermal conditioning * Mechanical conditioning	Heat treat, fire, work harden condition parts for a product. Include metals, plastics and ceramics if possible.	5%
- Assembling * Bonding materials - Adhesive bonding - Fusion bonding * Fastening materials - Mechanical fastening - Mechanical force	Assemble parts to produce a product using a variety of techniques including - adhesives - welding (fusion bonding) - mechanical fasteners - interference fits - seams	10%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Discovering manufacturing - Transforming processes - Managing - Systems model of manufacturing	View a film which shows (1) obtaining raw materials, (2) converting raw materials into standard stock and/or (3) producing finished products from standard stock. Run a teacher developed line production. (This unit is a quick overview of manufacturing materials, materials processing, management, and systems. It provides general experiences and discussions which introduce the course, i.e. What is Manufacturing, What is material processing, What is management?	5%
Obtaining resources for manufacturing - Materials * Direct * Indirect - Human * Managerial * Scientific/technical * Office/clerical * Worker/operative - Capital * Plant * Equipment - Finance * Debt * Equity	Separate clay from soil and produce a product. Obtain and test sand for its possible use as molding sand. Harvest a tree (or limb) and use it for a plaque. View films on mining, drilling, and/or harvesting. Analyze "want ads" to determine types of human resource used by manufacturing. Check equipment catalogs to determine types and cost of typical manufacturing equipment. (These activities combine the content of this category on the next page of the outline).	5%

COURSE TITLE

"Product and Production System Design" 8175 — 18 weeks

(Level IV Medium schools) — Grades 9 - 12

COURSE DESCRIPTION

Product and Production System Design is a course which provides students with an introduction to the processes used to develop and specify product ideas and to design and operate systems to produce products. Emphasis is placed on the sequence of action which changes a designer's product idea into a product which meets specified quality standards.

COURSE OBJECTIVES:

Upon completion of the course, students should be able to:

1. Identify and define a design problem.
2. Visualize product ideas.
3. Refine and communicate product ideas.
4. Critically evaluate product ideas.
5. Engineer products.
6. Specify product characteristics.
7. Analyze product drawings, bills of materials, and specification sheets to determine operations required, quality standards, and material specifications.
8. Select a sequence of operations required to manufacture a product.
9. Design and construct tooling.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Finishing * Selecting finishes * Preparing materials for finishing * Applying finishes * Curing finishes	Apply finish to products. If possible apply both organic and inorganic materials using a variety of methods, i.e. dipping, spraying, electroplating.	10%
Analyzing manufacturing outputs - Determining types of outputs * Raw materials * Industrial goods * Finished goods * Ancillary outputs	Collect and catagorize a variety of manufacturing outputs including both primary outputs (materials and products) and ancillary outputs (scrap, pollutants, etc.)	4%
- Categorizing material properties * Mechanical properties * Physical properties * Chemical properties * Thermal properties * Electrical and magnetic properties * Accoustical properties * Optical properties	Collect and categorize materials according to their various properties, i.e. hardness, sound absorbency, density, chemical resistance, courseness, color.	4%
- Determining material properties * Designing or selecting material tests * Conducting material tests * Reporting test results	Design and/or conduct several tests on products or materials to determine their properties. Prepare reports of test procedures and results.	17%

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CONTENT	REPRESENTATIVE ACTIVITES	TIME
Introduction to product design and production systems - System elements * Research and development - Research - Development - Product engineering * Production - Manufacturing engineering - Production planning & control - Plant engineering - Quality control - Manufacturing - System components * Inputs * Processes - Design Processes - Material Processes - Management * Outputs * Operating context - Company objectives - Societal goals	Film that shows the manufacture of products--emphasize how the product was designed and later produced. Teacher designed simple introductory line production. Emphasize: - product design * Simplicity * Appearance * Function * Value - product drawings as a communication devise - plant layout and material handling - tooling - sequence of operations - inspection and quality control	5%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Product design system - Foundations of design * The design process * Design approach - Consumer orientation - Production orientation	Introduce a creative design problem such as a mousetrap powered car, package for a falling egg, etc. Identify products which represent - Consumer approach: determine needs and wants, then design product - Production approach: design a product, then create a need or want	10%
Identifying and defining design problems - Determining the problem - Gathering information * Consumer needs and wants * Competitive analysis * User characteristics (anthropometric data) * Environmental data - Determine design approach * Design fundamentals - Function - Materials - Appearance - Construction techniques * Design elements - Line - Shape - Mass	Given a basic design problem or direction, each student should: - determine consumer opinions about the features of an acceptable product - describe and analyze competitive products - list desirable features for a functional and economic product - prepare a complete statement of the design problem. Include a list of company and external restrictions. (Four or five students in each class are given the same design problem. Later all students with the same problem form a product idea evaluation group and then a product engineering team. The number of different design problems used in any one class will vary with the number of students enrolled in the class. A typical problem would be: "You have been recently employed as a designer for the Play-Fast Toy Company. Your company's sales personnel have brought back reports of a successful new competing metal truck line. Play-Safe's marketing group has conducted a	

CONTENT	REPRESENTATIVE ACTIVITES	TIME
* Design principles - Balance - Proportion - Harmony - Emphasis - Rhythm - Defining the problem * Criteria * Limitations * Problem statement	survey which indicated dissatisfaction with the metal toy's sharp edges and corners. Management has assigned you the task of designing a new wood toy truck line which meets the following criteria (Prepare a list of criteria). **The design assignments should require a set of products so that a design theme can be carried out.	
Developing product ideas - Visualizing preliminary product ideas * Sketching techniques * Preparing rough sketches * Preparing detailed sketches - Refining product ideas and sketches - Communicating product ideas * Perspective sketching * Preparing renderings * Modeling * Constructing mock-ups - Evaluating product ideas * Constructing prototypes * Managerial reviews	Each student should take his/her design statement then: - produce a number of rough sketches for * complete product ideas * Ideas for components for the products - prepare a detailed (dimensioned) sketch - refine the rough sketches - prepare a rendering of their idea - build a soft(styrofoam, cardboard) mock-up The students should be grouped in teams of three to five. They should: -evaluate the product ideas of each member of the team	12% 4%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Technical reviews - Market reviews - Financial reviews Engineering and specifying products - Product engineering - Specifying product characteristics * Engineering drawings - Detail drawings - Assembly drawings - System drawings * Bills of materials * Specification sheets - Testing product performance * Designing and conducting tests * Reporting test results	- select the idea which best meets design, manufacture, market, and financial criteria, - brainstorm the selected idea to improve it. As a team, the students should prepare the following for the selected and improved product idea: - a detail drawing for each part - assembly drawings for each assembly - a bill of materials If time permits, the group should design and conduct tests to determine product safety, reliability, functionality, etc.	14%
Establishing production methods - Selecting operations * Classes of operations * Establishing operations - Product analysis - Operation descriptions * Determining support activities - Inspections - Transportations	Using one developed product from the product design phase of the class or a set of drawings from the teacher, the students will develop an efficient and appropriate production system. Individually or within groups, the students should: - analyze the drawings and list all required operations - prepare an operation sheet for each part	5%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- delays - storages - Sequencing operations * sequencing operations for each part * sequencing operations for the product	- prepare a flow process chart for each part - prepare an operation process chart for the product	
Engineer the production facilities - Selecting a layout system * product layout * process layout - Determine space needs - Allocate space - Engineer a material handling system	Groups of students assigned to each part of the product will: - determine the space needs for manufacture - prepare a suggested plant layout - develop a system for materials handling	5%
Design and fabricate tooling - Determine the tooling needs - Develop possible tooling solutions - Select the best solution - Prepare tooling drawings - Fabricate, install and test tooling	Individually or in pairs, the students should design, fabricate, install, and test a piece of tooling.	20%
Develop an inspection system - Determine inspection needs * determine quality standards * list critical features or dimensions	Individually or in small groups, students should determine an inspection need, and develop a system to control that characteristic. This would include: - listing the need	7%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Select inspection techniques * Design inspection devise * Prepare inspection instructions - Develop an inspection reporting system * Part-marking system * Inspection results reporting	- designing and building an inspection devise - preparing instruction for an inspector	
Schedule manufacturing activities * Master schedules * Daily work orders * Production reports	As a class, develop long-range and daily production schedules.	
Operate the production system - Train workers - Produce products * Parts * Subassemblies * Finished products - Inspect inputs and outputs * Incoming materials * Work-in-progress * Finished products - Supervise workers - Monitor production activities * Time studies * Quality reports * Production quantities	- Students should be trained for jobs on the production line: - incoming materials should be inspected - parts and assemblies should be fabricated and inspected - finished products should be completed and inspected - selected jobs should be time studied - efficiency and appropriateness of the production system should be discussed	13%

COURSE TITLE

"Designing Products" (8116) 18 weeks

(Level IV Large Schools) Grades 11-12

COURSE DESCRIPTION

The course, Designing Products for Manufacture, provides students with a comprehensive introduction to the systems used by manufacturing enterprises to design, develop, and engineer products to meet the needs and wants of consumers. Emphasis is placed on an activity-centered study of the specific tasks associated with design problem identification and conceptualization, design review, product design interpretation and specification, and product testing.

COURSE OBJECTIVES:

This course is designed to provide the students with the opportunity to:

1. Understand research and development as a managed system with inputs, processes and outputs when operated in a company and societal context.
2. Understand the functions and task of research, development and product engineering.
3. Appreciate and use the design process.
4. Differentiate between consumer and production design orientation.
5. Conceptualize, visualize and communicate a product design.
6. Develop a data base for designing a specific product.
7. Design a product with consideration for function, selling, and manufacture.
8. Test the appropriateness of a product design.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Design in Manufacturing - System elements * Research * Development * Product engineering - System components * Inputs * Processes * Outputs	Film that shows the manufacture of a product. Emphasize how the product was designed Introduce design with an open-ended design problem. The emphasis should be on using the design process to develop a unique solution. A typical assignment: "Design a vehicle that will travel the maximum straight line distance on a flat hard surface propelled only by a mousetrap spring." "Design a device that will protect a raw egg from the effects of a three-story free fall." "Design a device that spins, similar in nature to a top. The purpose of the device is to spin for an extended period of time." (The above assignments should have size, materials, cost, and performance limitations developed. Also, kits of materials for each student may be provided.)	2%
Foundations for Product Design - Types of design * Innovation * Adaptation * Imitation - Design orientation * Consumer * Production - The design process * Identify problem * Research and analysis * Generation of ideas * Experimentation and refinement * Final solution * Design report & presentation * Evaluation		10%

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CONTENT	REPRESENTATIVE ACTIVITES	TIME
Identifying and defining design problems - Determining the problem - Gathering information * consumer needs and wants * competitive analysis * user characteristics (anthropometric data) * environmental data - Establishing goals and objectives for the solution - Analysis of data - Determine design approach * design fundamental - function - materials - appearance - construction techniques * design elenents - line - shape - mass * design principles - balance - proportion - harmony	The remaining activities are structured around a major course assignment. A sample assignment is: "You have been recently employed as a designer for the Road-Bed Toy Company. Your sales personnel have brought back reports of a successful new small metal train introduced by your major competitor. The line is taking a share of the market from your present line. The management of Road-Bed Toy Company plans to take advantage of an identified weakness in the competitor's product which is sharp corners and edges. Management has authorized the design and development of a wood train line to meet the following criteria (list criteria)." Several similar design assignments will be needed for each class. The same assignment will be given to 4-5 students in each class. The students work independently during the product design phase of the activity and in groups during the product evaluation and engineering phase. Given the basic design problem each student will independently (or in pairs) - design and conduct a market survey to determine consumer preferences for the intended product. - complete a competitive analysis by describing and analyzing competing products. - list the desirable features of a functional and economical product. * The assignment should require the students to design a set of products so a design theme will have to be carried out; i.e., a set of toys, a set of desk	10%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Emphasis - Rhythm - Defining the problem * Criteria * Limitations * Problem Statement	accessories, etc. (prepare a complete statement of the design problem. Include a list of company and external restrictions.)	
Developing product lines - Visualizing preliminary product ideas * Sketching techniques * Preparing rough sketches - thumbnails - roughs * Prepare detail sketches - Refining product ideas and designs - Communicating product ideas * Perspective sketching * Preparing renderings * Modeling * Constructing mock-ups	From their design statements, students should: - produce a number of rough sketches for * complete product ideas * product components - refine the rough sketches - prepare a detailed (dimensioned) sketch from the roughs - prepare mock-ups of product design - prepare renderings of product design	35%
Screening product ideas - Analyzing product ideas * Manufacturing feasibility * Financial risks and rewards * Marketability	Students working on the same design problem should form a design evaluation team. They should objectively evaluate each student's designs and select the best design in terms of design, manufacturing, market, and financial criteria.	3%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
* Functionality - Approve appropriate design		
Engineering and specifying products - Product idea analysis * Analysis * Brainstorming * Modification/Simplification - Specifying product characteristics * Engineering drawings - Detail drawings - Assembly drawings - Systems drawings * Specification sheets * Bills of materials * Cost analysis - Modeling the design * Prototype - Test the product performance * Designing or selecting tests * Conducting tests * Reporting test results	Student design team should carefully analyze and improve selected design through brainstorming activities. The student design team should specify the characteristics of the modified product design by preparing: - engineering drawings - bills of materials - specification sheets (if needed) NOTE: assign the work load so that each student produces one or more detail drawings and at least one assembly drawing. A cost analysis for the products should be completed. The design team should build a prototype of the product design(s). Each student should design or select a product test, conduct it and report the results. The product can be tested for durability, safety, functionality, operation, etc.	35%
Present product design	The product design team should present their product to "management" for approval. The	5%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
	presentation should be a formal, structured oral and written report. Emphasis should be basis of design for manufacture, for marketing and for function.	

COURSE TITLE

"Manufacturing Systems" (8115) 18 weeks

(Level IV Large Schools) Grades 9-10

COURSE DESCRIPTION

Manufacturing Production Systems provides students with an introduction to the design and operation of production systems. Emphasis is placed on efficient and appropriate plan layouts, process selection and sequencing, materials handling system design, quality control procedures, production planning and control activities, work measurement practices, and product manufacture. The main activity: students establish a production system for a product as specified by a set of engineering drawings, bills of materials, and specification sheets.

COURSE OBJECTIVES:

Upon completion of the course, students should be able to:

1. Analyze a set of drawings, specification sheets and bills of materials to determine:
   a. the operations needed to produce a product,
   b. specified quality standards,
   c. material specifications.
2. Sequence operations for efficient manufacture.
3. Design and construct functional inspection devices.
4. Prepare effective quality control motivational materials.
5. Schedule the manufacture of parts, subassemblies and final assemblies.
6. Determine material handling needs for a production system.
7. Supervise manufacturing activities.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Introduction to production systems - System components * Inputs * Processes - Material processing - Management * Outputs * Operating context - Company goals - Societal objectives - System elements * Manufacturing engineering * Production planning and control * Plant engineering * Quality control * Manufacturing - System types * Custom * Intermittent - Job-lot - Batch * Continuous	Film that shows the manufacture of products--emphasize system components and elements Teacher designs simple introductory production. Emphasize: - plant layout - material handling - tooling - quality control - sequencing of operations Divide the class into three groups: GROUP A: custom produce a product GROUP B: Job-lot produce a product GROUP C: Continuous (line) produce a product NOTE: product should be simple and produced with common hand and portable electric tools. Compare the three productions in terms of - skill of the workers required - quality of the output - efficiency	6% 10%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Establishing production methods - Selecting operations * Classes of operations - Casting and molding - Forming - Separating - Conditioning - Finishing - Assembling	The class will be given a set of drawings, bills of materials, and specification sheets which they will use to complete all the remaining activities. These activities will result in an efficient and appropriate production system for the manufacture of the specified product.	10%
* Establishing operations required - Product analysis - Operation sheets	Analyze the product and list all required operations* Prepare an operation sheet for each part.	
* Determining required support activities - Inspections - Transportation - Delays - Storage		
- Sequencing operations * Sequencing operations for each part with flow process charts	Prepare a flow chart for each part.	
* Sequencing operations for a product with operations process chart	Prepare an operation process chart for the product. *The students may be assigned to work on each assignment as individuals or members of a design group.	

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Engineering production facilities - Selecting a layout system * product layout * process layout - Determine space needs * manufacturing areas * storage * aisles - people needs - material's needs * auxiliary - Allocating space * plant layouts - models - drawings - Designing and installing handling systems * analyzing requirements * selecting system type - fixed path - variable path - Fabricating and installing material handling systems	Divide the class into groups and assign a part to each group which should then: - design an efficient plant layout for its part - develop a material handling system for its part	10%

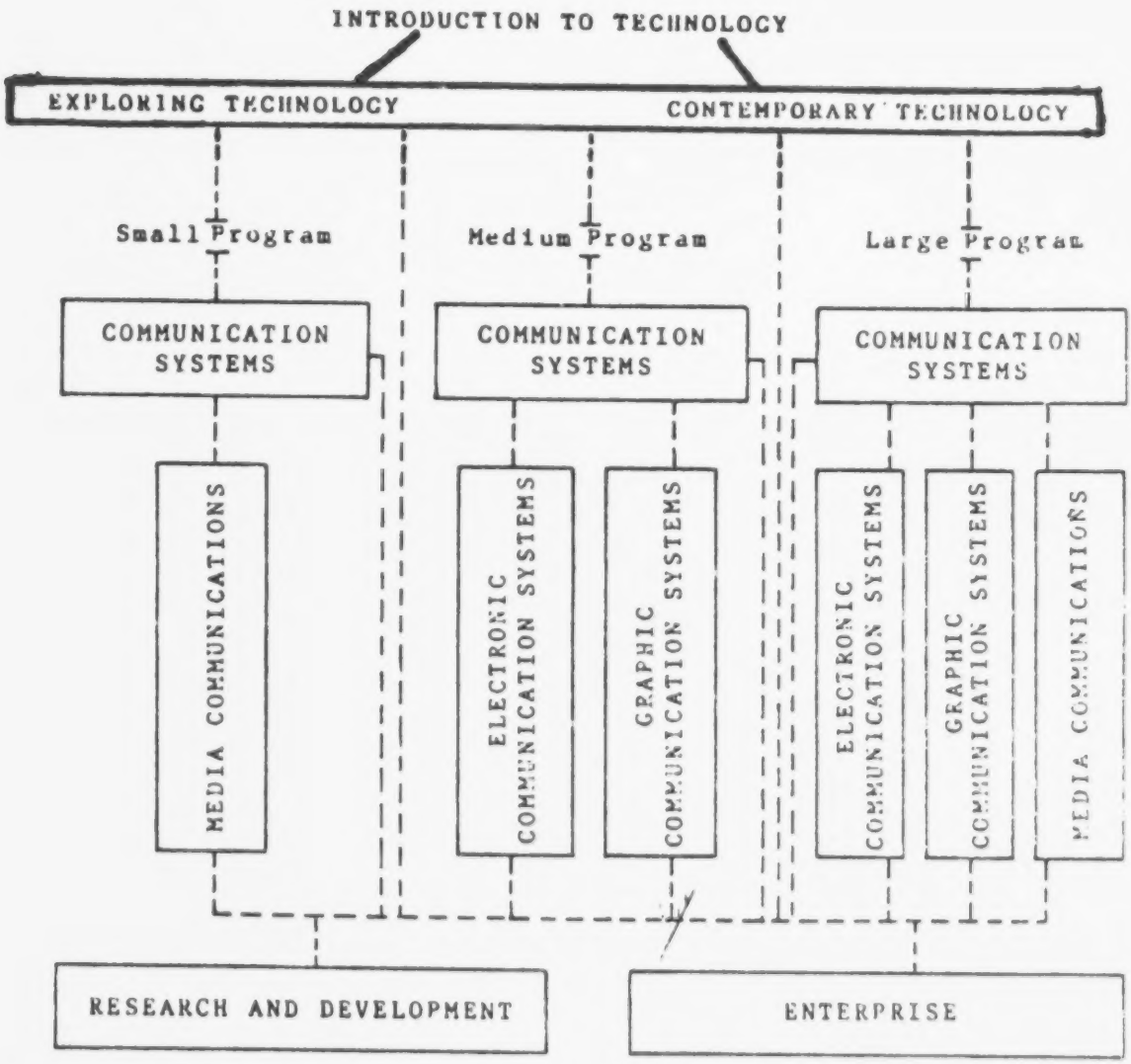
CONTENT	REPRESENTATIVE ACTIVITES	TIME
Designing and fabricating tooling - Types of tooling * Jigs * Fixtures * Patterns and templates * Formed cutters - Part clamping devices * Mechanical * Hydraulic/pneumatic - Designing tooling * Determine tooling needs * Develop possible solutions * Select best solution * Prepare tooling drawing * Fabricate tooling * Test tooling * Install tooling	Assign a specific tooling need to each student or pair of students. They should (1) list possible ways to tool up for the task, (2) sketch these solutions, (3) select the best solution, (4) prepare engineering drawings for the tooling, (5) build, test and install it.	30%
Develop a quality control system - System elements * Motivational program * Inspection system - Determining quality standards * Product drawing analysis * Process analysis	Assign student groups to: - prepare a quality control motivational program theme - prepare motivational materials - determine critical features to be inspected for assigned part - develop inspection devices for each task	20%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Selecting inspection techniques * Designing inspection devices * Preparing inspection instruction - Developing an inspection reporting system * Part marking system * Inspection results reporting	- develop a method to tag parts for rework and reject - develop a system to report the results of the inspection activity by day and/or week	
Scheduling manufacturing activities - Master schedule - Daily production - Work orders - Production reports	Have student groups develop master production schedules, daily work orders and daily production report forms.	4%
Operate a manufacturing system - Train workers - Produce products * Parts * Subassemblies * Finished products - Inspect outputs and inputs * Incoming materials * Work in process * Finished products - Supervise workers	The students should install their tooling, arrange the laboratory for production, install the material handling system, locate inspection stations, and operate the system. Time studies, production reports and quality control reports should be used to determine the efficiency of individual operations and of the total system.	10%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Monitor production activities * Time studies * Quality analysis * Production quantities		

COMMUNICATION COURSES

*(INTEGRATED TECHNOLOGY)



*NOTE: WHILE THIS IS A PART OF THE SCOPE FOR INDUSTRIAL ARTS/ TECHNOLOGY EDUCATION, EXPENDITURES FROM VOCATIONAL FUNDS ARE RESTRICTED TO GRADES 7 - 12.

INTRODUCTION TO COMMUNICATION

Communication is a major industry in our world. More than half of the American population is involved with the generation, manipulation, storage, transmission or marketing of information. The purpose of this section is to introduce the student to classifications, terminology, technical systems and processes used by the industry and to provide representative activities that support those understandings. The section is broken into five major technical communication areas: graphic, electronic, computer, light, and acoustic.

Within each area, emphasis should be placed upon the domestic and global impact upon how people live. This is defined within the taxonomy as economic, political, values/ attitudes and environmental impacts, but should not be viewed as a restrictive list.

The graphic communication area introduces the traditional areas of printing and photography, but suggests a somewhat broader view. Within printing, electrostatic and ink jet are now viewed as significant reproduction methods. Processes independent of reproduction methods are described. Emphasis should be placed upon the printed products,being classified by both use and type of material. The concept of consumable printed materials includes such things as newspapers, napkins, paper cups, or anything that carries an image, but is intended to be used once and then discarded. Permanent materials, however, are intended to survive beyond

immediate, or one-time use such as books, ceramic dinner plates, or floor coverings. Photographic communication includes both film and electronic imaging. While electronic imaging relates to several other systems within the industry, it is still viewed as an important part of photo methods.

Electronic communication is a significant area that includes telecommunication, hard-wired systems, and computers. The emphasis is upon communication methods and not necessarily hardware. While a computer is hardware, the suggested view is the application of hardware and software to expand human abilities. Nearly every area of technical activity uses computers today, but this topic examines how computers are specifically used to communicate with humans or with other computers.

Light communication is an area rarely examined in this type of curricula, yet is an important method of transmitting information. "Interactive," in the taxonomy, describes methods to send and receive information between machines and humans or between machines and machines; a major example is the use of lasers. "Passive," on the other hand, defines methods that are continuous, on-going sources. Examples include neon signs, airport landing lights, stop-and-go lights, and navigational aids (lighthouses).

Acoustic communication falls into two areas. The first is sonic detection. It represents the generation of sound waves to gather information; common areas of application are medical research, (diagnosis of heart defects, pregnancy tests), manufacturing (to locate potential defects in welds) and transportation (to detect traffic flow or activate a light signal). The second major acoustic communication area is the storage and retrieval of information. Sound information is stored on magnetic tape, for playback through a tape drive, or in mechanical form on a record.

The taxonomy for the communication area is carried to four levels of specificity. It is intended to describe the field, and define current industrial and social realities. It is not intended to be restrictive, but rather to give a framework for further expansion. Individual classroom teachers are encouraged to expand the model to specific applications.

COURSE TITLE

"Communication Systems" (8125) 18 weeks

(Level III - All Schools) Grades 9-10

COURSE DESCRIPTION

This course is a general introduction to technical communication systems and processes within the communication industry. It provides representative activities that support those general understandings, and forms a base of understanding for further exploration.

COURSE OBJECTIVES:

Upon completion of the course, students should be able to:

1. Understand the limitations of humans communicating with humans through the five senses.
2. Recognize that technology amplifies, expands and creates new abilities to receive and send information.
3. Recall that communication systems are defined as graphic, electronic, light, acoustic, and computer technologies.
4. Complete activities that develop understandings of the five communication systems.
5. Recognize typical products produced by the communication industries to create, manipulate, store, send or receive and market information.
6. Understand the impact of technological systems upon our world, including the economic, political, value/attitude and environmental dimensions.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Introduction - What is communication: * Information transfer: Human-Human * Information transfer: machine-machine * Information transfer: machine-human - How do humans communicate: * Taste * Olfactory * Visual * Auditory * Touch - Human limitations * Environmental * Physical * Cognative/Experimental * Sense Technical Extensions - Amplify * Visual (telescope) * Auditory (hearing aid) - Expansion * Visual (television) * Auditory (telephone)	Films such as "Why man creates" Have students conduct sensory deprivation experiments - smell an onion for 30 seconds then identify the difference between two perfumes. - Blindfolded, listen to another person's description of an item and identify it. Demonstrate typical amplification and expansion equipment/process.	10%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- New abilities * Storage * Retrieval Classifications of communication systems - Graphic communication - Electronic communication - Light communication - Acoustic communication		
Graphic Communication - Printing methods * Relief * Screen * Lithographic * Gravure * Electrostatic * Ink Jet - Printing processes * Image design * Image assembly * Image conversion * Image carrier preparation * Image transfer * Finishing - Photographic methods * Film imaging * Electronic imaging	Field trip to commercial printer Have students individually or in groups assess the audience. Design and produce (a) a greeting card or (b) cover for a 45 R.P.M. record (Use clip art, dry transfer letters, Kroy-Type for copy and produce multiple copies by Electrostatic means.) Films, such as, "Graphic Communications-we used to call it printing" (DuPont) Assess space dedicated to photos and copy in local or school newspapers Field trip to a commercial photographer	30%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Photographic Processes * Image design * Image assembly * Image exposure * Image conversion * Image reproduction * Image finishing - Graphic communication industry/products * Publishing * Film * Art/advertising * Packaging * Commercial printing * Commercial photography - Impact of graphic communication * Economic * Political * Value/attitudes * Environmental	Using room light handling films and a photo flood lamp produce a photogram. (cover the film with found objects- coins feathers, leaves- Then expose and develop it.)	
Electronic Communication - Telecommunication methods * one-way transmission (radio, TV) * two-way transmission (radio, RADAR) - Telecommunication processes * Designing * Encoding * Transmitting * Storing/Retrieving * Receiving * Decoding	Field trip to a radio or TV station Films such as "Pushing the Limits" IBM Demonstrate/operate a CB or Ham Radio Run computer program - Type in name, address, etc.	30%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
-Hard-wired systems * One-way (voice, data, facsimile, P.A.) * Two-way (voice, telephone) -Hard-wired system processes * Designing * Encoding * Transmitting * Storing/Retrieving * Receiving * Decoding -Computer Systems * Analog * Digital - Computer Processes * Input * Storage * Process * Output -Computer Interface * human * machine - Electronic Communication Industry Products * Broadcasting * Telephone * Telegraph * Data Processing * Information services	Using a 9 volt battery, build and operate telephone intercom system	

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Impacts * Economic * Political * Value/attitudes * Environmental		

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Light Communication - Interactive Systems * Sources (coherent, non-coherent) * Processes - Design - Encode - Transmit - Receive - Decode - Passive Systems * Sources (coherent, non-coherent) * Processes - Design - Encode - Transmit - Receive - Decode - Light Communication Industry Products * Telephone * Broadcast * Data Processing	Build a sensing device using photocell, photo-diode or photo transistor or a solar cell. Speaker from telephone company on "Fiberoptic Transmission"	5%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Acoustic Communication - Sonic detection systems * Gas * Liquid * Solid - Sonic detection process * Modulation * Transmission * Receiving * Decoding - Storage and retreival systems * Magnetic * Mechanical - Storage and retreival system processes * Encode * Store * Retrieve * Decode - Acoustic Communication Industry Products * Health services * Information services * Recording - Impacts * Economic * Political * Value/Attitudes * Environmental	Build a paper machine or cardboard parabolic dish and record a distant conversation. Analyze the recording. Administer a hearing test	5%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Managing Communication Systems - Establishing the organization * Generate capital * Employ management * - Design the campaign * Establish theme * Determine media forms - Design the message * Assess the audience * Research means to impact audience * Develop message through - storyboards and scripts - rough, refined and comprehensive sketches - Prepare to transmit the message * Plan and schedule production * Employ and train personnel * Prepare images or stage production * Procure materials * Establish physical facilities - Produce the message * Print * Record - Deliver the message * Broadcast * Ship	Give groups of students or the class instructions such as: "You have received a request to bid on producing an advertising campaign for a school dance (or play, sporting event, etc.). Form a company to select, design, and produce the media with proper consideration to the financial and personnel activities."	20%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Maintain financial and personnel records * Budgets * General and cost accounts * Wage records - Liquidate company.		

COURSE TITLE

"Graphic Communication Systems" (8135) 18 weeks

(Level IV - Medium and Large Schools) Grades 11-12

COURSE DESCRIPTION

The graphic communication course provides students with an introduction to the graphic communication field. Emphasis is placed on the development of a conceptual understanding of the technical processes and managerial activities related to two major areas--printing and photography.

COURSE OBJECTIVES:

The course is designed to provide students with an opportunity to develop an ability:

1. Identify major areas associated with the graphic communication field.
2. Identify and use the materials and equipment associated with the photographic field.
3. Compose and develop a photograph for an assigned theme.
4. Identify and use the materials and equipment associated with the printing industry.
5. Produce a product using a common printing process.
6. Identify and discuss the purposes of the graphic communication industry.
7. React to the way graphic communication affects the community, state, and nation in terms of social, economic and political impacts.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Introduction to Graphic Communications - Defining graphic communication * Photography * Printing - Impact of graphic communication * Information dissemination * Opinion influences (advertising) * Entertainment * Packaging	Show films, such as "Graphic Communications--We used to call it printing" Students should collect examples of graphic image. Class discusses use and impact (how it influences our society and culture)	8%
Photography - Photographic fundamentals * Light sensitive materials * Exposure systems * Processing systems * Light sensitive materials Silver-based Non-silver based	Students produce photograms, using room-light handling film, and rapid access chemicals	25%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Exposure Systems * Light monitoring * Light generation * Exposure techniques * Monitoring techniques - Sequence of the production of photographic products * Image design * Image assembly * Image exposure * Image reproduction * Image finishing	Students expose one roll of b & w film, using various light sources, and process to see different results--make a contact sheet Students produce five prints within a theme. The theme might be topics such as "school life" "environmental problems," "local leaders," "rest" or "my pets". They will: 1. Plan the photographs 2. Bring together the elements and prepare lighting (if necessary) 3. Expose the images 4. Develop film and prepare prints 5. Mount the photographs for display on posterboard	
Printing - Use of printed products * Materials * Paper * Non-paper * Application * Consummable * Permanent - Printing fundamentals * Printing sequence * Image design * Image assembly	Students classify a variety of printed products as assembled by the instructor	32%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
* Image conversion * Image carrier preparation * Image transfer * Image transfer methods * Impact - relief - lithography - gravure - screen * Non-impact - electrostatic - ink jet - Graphic communication industries * Publishing * Film * Art/advertising * Packaging * Commercial printing * Commercial photography	Students collect examples of printing and, with the instructor, determine method of image transfer. Students design individual stationery, given standard size by the instructor. Instructor provides clip art and dry transfer letters or Kroy-type. Use electrostatic plates, or PMT-type plates to reproduce the images on an offset duplicator. Students design an individual project, such as greeting card, game score card, poster, form, or package. They begin with thumbnail sketches and proceed through mechanicals. Using available equipment at least 50 copies are produced, using a film-based reproduction system (litho, screen).	
Managing graphic communication industries - identifying a need * Mass media * Individual * Product	Students survey the community to determine types and numbers of graphic industries existing locally. They may use the telephone directory, or local newspaper to assemble information. Students visit a local commercial printer or photographer.	30%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Establishing an organization * Structuring * Employing personnel * Financial - Designing a product * Research * Design * Testing (market research) - Producing the product * Procurement of materials * Fabrication * Quality control - Selling the idea * advertising * Sales techniques - Balancing the accounts * Accounting departments * Profit and Loss statements - Distributing the product	Students survey market for a potential product. Identify specific goal. Class develops a product design and formulates product direction. Students plan production sequence, secure materials (after developing cost structure) and produce a product. The product might be a printed piece, or individual photographic images. Students develop a marketing plan, and deliver the product. Students determine cost of product--material, overhead, and labor costs--and recognize profit and loss statement.	
Graphic Communication System Impacts - Economic - Values/Attitudes - Political - Environment Trends in Graphic Communication - Historical - Contemporary - Future developments		5%

COURSE TITLE

"Electronic Communication Systems" (8136) 18 weeks

(Level IV -- Medium and Large Schools) Grades 11-12

COURSE DESCRIPTION

The electronic communication course provides students with a general introduction to contemporary communication technology including telecommunications, hard-wired, computer, light, and acoustic systems. An integral part of the course is an overview of the products and impacts of electronic communication systems and the nature of the communication industry.

COURSE OBJECTIVES:

At the end of the course the student will be able to:

1. Describe the major electronic communication systems.
2. Characterize the major components of electronic communication systems.
3. Determine the nature and composition of the electronic communication industry.
4. Conduct technical experiments in the area of electronic communications.
5. Assess the social/cultural impact of communication products and technical systems.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Introduction to electronic communication systems - The nature of messages - The nature of information signals * Telecommunication systems * Hard-wired systems * Computer systems * Light communication systems * Acoustic systems	Speaker of electronic communications Demonstrate a variety of systems - an overview	5%
Telecommunication systems - Fundamentals of electromagnetism * Magnetic fields of force * Electromagnetic radiations * Signal Transmissions - Applications for telecommunication systems * One-way signal generation - Radio and television telecommunications systems (microwave, satellite) * Designing the message * Encoding the message - transducers - signal modulation * Transmitting the signal - oscillators - amplifiers - antennas - Duplexing/Multiplexing * Receiving the signal - detectors * Decoding the signal	Test radio signal distribution of walkie-talkies through steel, wood, cement, and water Fabricate a printed circuit board then construct a crystal radio or an AM radio Visit a local radio or TV station or a microwave relay site Using bread board demonstration panels demonstrate signal encoding, transmission, receiving and decoding	18%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- transducers * Storing/Retrieving - Magnetic tape and disc		
Hard-wired systems - Fundamentals of electron action * Conductors * Insulators - Application of hard-wired systems * One-way signal transmission * Two-way signal transmission - Voice and data communication systems (telephone, telegraph, teletype, facsimile) * Encode the message - transducers - signal modulation * Transmitting the signal - wire (single & multistrand) - Coaxial cable * Information processing - central processing unit * Information output - Central processing unit * Information output - visual display screen - printers - plotters * Computer interface - human to machine - machine to machine	Build an intercom using an audio amplifier IC Visit computer sites in the business community Invite a speaker on computers in business and industry	18%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Light Communication Systems - Fundamentals of light energy * energy channel * signal transmission - Light Communications Systems * interactive (fiber,optic) * Passive (signs, flashing signals) - Light sources * coherent light (laser) * non-coherent light	Build an optical (infrared sensing) communication unit Invite a speaker from the telephone company to discuss and demonstrate fiber optic communication systems. Create a sound-modulated light communication system with a transistor radio, photovoltaic cell, flexible film diaphragm, and flashlight.	13%
Acoustic Communication System - Fundamentals of acoustic energy * signal transmission * transmission media (gas, liquid, solid) - Sonic detection systems (sonar) * signal generation and modulation * signal transmission and reception * signal decoding - Acoustic storage/retrieval * mechanic (phonographic) * magnetic (tape/disc) * processes - encode - storage - retrieval - decode	Build a portable public address system using LM380 IC. Visit local fishing operation or hospital to observe ultra-sonic devices in use.	13%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Electronic communication products - Entertainment - Information/Data - Detection - Computations - Data Exchange - Control	Demonstrate and/or view common entertainment products Film Speaker	5%
Electronic communication system Impacts - Economic * Workforce * Market place * National-global - Values/attitudes - Political * Regulation and control * Government provided communication services - Environment	Illustrate the paths of community/local microwave pathways and the telephone trunk cables on a topographical maps. Collect and discuss magazine and newspaper articles which present communication system impacts.	8%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Communication industry - Industry and society - Organization of electron communication industry * Structure, organization, staffing * Financing * Legal - Creating communication/information * Designing * Cost analysis * Producing/generating/serving/products * Controlling product quality * Controlling finance and personnel function * Distributing products	Design an electronic communication message or service, then: 1. Plan and design the message 2. Determine its cost 3. Plan for its production 4. Produce it or provide the service. 5. Evaluate its effectiveness.	15%
Trends in electronic communication * Historical * Contemporary * Future developments	Create a list of possible inventions in electronic communications which we may see in the next 20 years. Speaker * Invention/innovation * Industrial developments	5%

COURSE TITLE

"Media Communications" (8145) 18 weeks

(Level IV Small and Large Schools) Grade 11-12

COURSE DESCRIPTION

The purpose of this course is to provide students with a general introduction to the design, planning and production of media used in contemporary society. The content links graphic communication with acoustic and electronic communication, and allows the instructor to build from a technical base, while exciting students with the reality of producing media. The goal in the course is to produce a magnetic cassette tape recording for sale to a local market. All phases of design, planning and marketing are covered.

COURSE OBJECTIVES:

The course is designed to provide students the opportunity to develop an ability to:

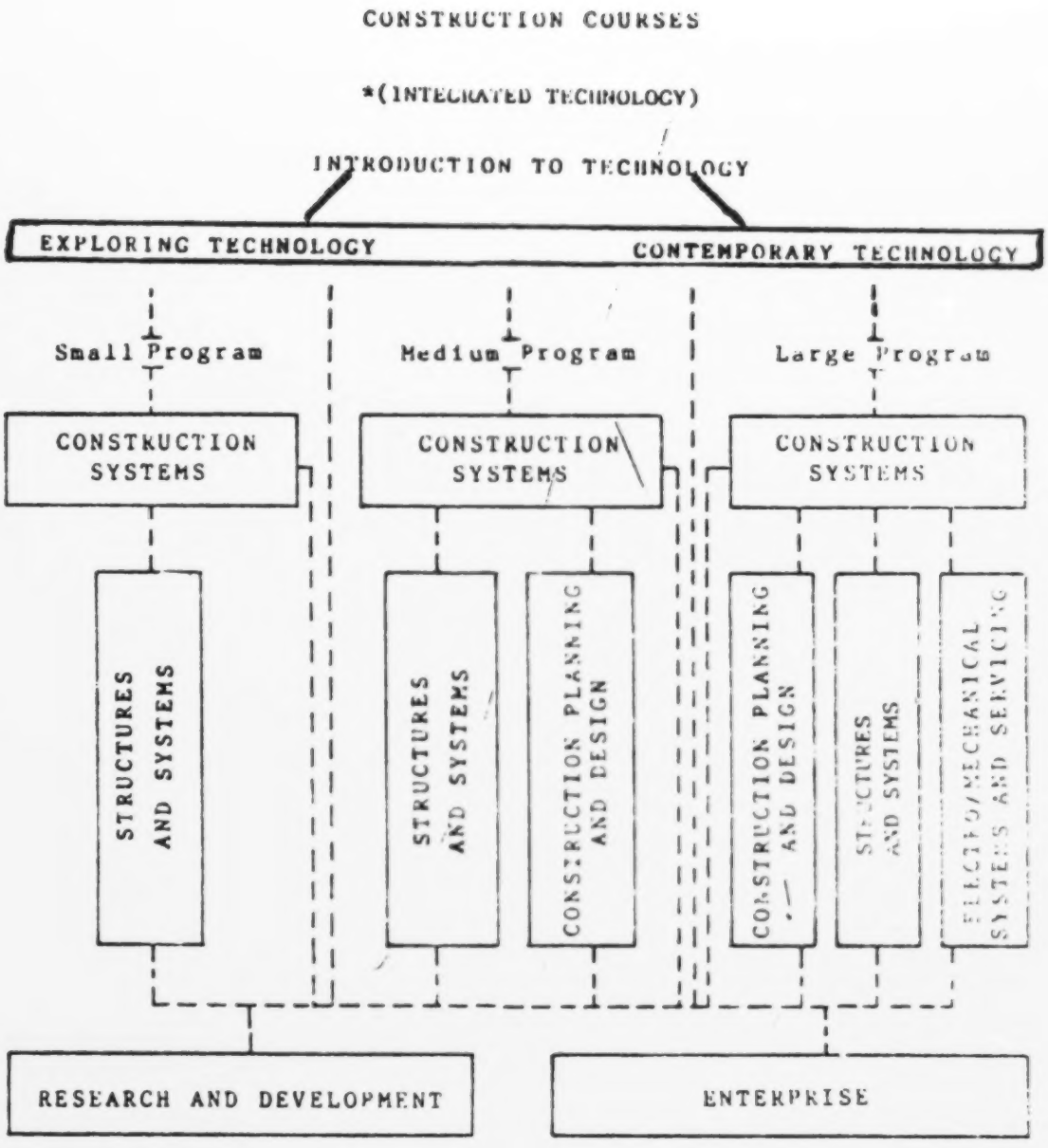
1. Recognize the impact of mass media upon our society.
2. Classify contemporary technical communication systems, including graphic, electronic, light and acoustic.
3. Follow through the steps of market research for a new product.
4. Develop advertising materials as a result of market research.
5. Understand and work with acoustic storage and retrieval equipment, and materials.
6. Develop media material, as a result of market research.
7. Design and produce packaging materials.
8. Produce magnetic tape materials, following media material plans, and using contemporary equipment.
9. Deliver a product to a market and evaluate the success of that product.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Introduction - Defining mass media * Print media * Broadcast media * Film & video tape media * Recording media - Social & Cultural impact of mass media * a television generation * role models through media * influencing public opinion/values * advertising as an opinion force	Students & teacher select samples of each type of media, and discuss availability in the local community Students monitor the number of minutes of television they watch each day--calculate the percentage of commercial minutes in an average hour of TV Students identify personal media hero/heroine, class picks two and evaluates characteristics--question the relationship of those characteristics to reality Class evaluates clothing--number of "trade" brand articles Class tests functional contents and operating characteristics of name brand cleaner vs. generic	10%
Overview of technical systems - Graphic * Printing * Photographic - Electronic * Broadcasting (telecommunication) * Computers - Acoustic - Light	Film Tour a broadcast station, advertising agency or a commercial printer--stress the technical system	5%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Message Design - Identification of a problem * Sell an idea * Sell a product - Market research * Definition of need * Examination of competition (Audience demographics - age, sex, socio-eco background, etc. - geographic concentration - buying patterns - Message synthesis * Selection of a specific message (product contents) * Selection of a medium of delivery (in this course, the medium is given)	Students will design, produce and market a cassette tape production. (School rock band, musical play, comedy hour, Christmas production, interviews, etc.) Students brainstorm suggestions for an idea or product to be carried on the tape. Students define the audience, and then survey that audience for evaluation (saleability) of the above suggestions. Students develop list of audience characteristics into a basic planning sheet. Students evaluate responses and compare information gathered on need and existence of competition. Students select a specific content for the tape.	15%
Advertising - A design is developed to sell the product to the audience. - The design is prepared & delivered. - The clear audience need is established.	Students develop a marketing plan. Students design an ad to promote a forthcoming product; they follow the steps in the taxonomy related to the method of advertising (e.g., if print, then image composition, conversion, carrier preparation, transfer and finishing).	8%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Acoustic Storage and Retrieval - Storage material * magnetic tape * digitized computer memory - Recording/playback systems * mono/stereo * track format * cassette/reel-to-reel * sound mixing - Equipment Operation	Students visit a local radio station or local engineer visits the school--focus is upon organization of systems and recording media. Students experiment with different recording/ playback systems (mono vs. stereo) (1,2,8,16 track) (cassette vs. reel-to-reel) (sound mixing via tracks). Students experiment with equipment controls, using various sound sources to determine equipment capability. Record a "test" track.	15%
Message/Goal Planning - Message refinement * script development * evaluation and redesign - Production arrangements * accumulation of sound effect devices * selection of performers * facility arrangements * pricing and purchase of magnetic cassette tapes	Students use information from market research phase to actually prepare a "script" that will be produced. "Experts" are used to evaluate the script or program and final refinements are made. Whatever type of script or program was developed students assemble devices for non-human sound effects (might be music, etc.). Students identify, audition, and select performers. As a result of experiments above with different sound systems, and the study of acoustic storage and retrieval (V-A, B & C) students prepare or locate a sould "studio" (might be "onsite"). Students determine from market plan how many tapes they might sell, and then negotiate the purchase of blank tapes.	12%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Packaging - The importance of packaging * as a container--considering product characteristics * as a sales campaign * as a means of establishing product identification - Design * examination of market research results * product characteristics * design of package - Production	Students collect a variety of product containers (for the same sort of product) and compare design, usability, and sales characteristics. Students analyze the characteristics necessary to package and sell magnetic cassette tape recordings. Students produce design for package. Students produce multiple copies of tape package (using available processes).	20%
Production - Rehearsal - Equipment testing - Recording - Editing - Reproduction of multiple copies from a master - Packaging	Students practice script both out of, and in "studio" situation; engineers test equipment and practice script sequence. Students produce recording using script or program outline and available equipment to make a master recording. Students edit the master, as necessary, and use existing equipment to make multiple copies.	10%
Delivery & evaluation - Delivery to market * timed to advertising * delivery matches market research - Evaluation * examination of audience reaction * did it sell * how to improve	Students deliver the product to the market, following the marketing plan developed above. Students evaluate the success or failure of venture.	5%



*NOTE: WHILE THIS IS A PART OF THE SCOPE FOR INDUSTRIAL ARTS/ TECHNOLOGY EDUCATION, EXPENDITURES FROM VOCATIONAL FUNDS ARE RESTRICTED TO GRADES 7 - 12.

INTRODUCTION TO CONSTRUCTION

The courses included in the study of construction systems include all of the key elements associated with designing, planning, and constructing a structure on-site. The principal purpose of each course is to provide a means for students to learn the major concepts associated with a variety of construction types. These include commercial and residential buildings, bridges and pipelines. The emphasis is on hands-on activities using construction tools and materials. In addition, emphasis has been placed on the relationships between the management and production elements as an integral part of a complete construction system.

The introductory course, "Construction Systems," provides the initial overview of all elements of a construction system and should be the first course students complete in the construction sequence.

The course in "Constructing and Servicing Structures and Systems" focuses on the construction practices basic to the erection of commercial, institutional, and residential structures and the installation of mechanical and electrical systems within these structures. This course should be offered in small and medium programs.

The course "Construction Planning and Design," which should be offered in medium and large schools, focuses on the development of understandings of the practices involved in initiating, designing, financing, and engineering constructed works. This course, also, emphasizes the future of the construction industry and the impact of

construction on the environment.

The courses in "Constructing and Servicing Structures" and "Electro/Mechanical Systems" allows the content from the course "Constructing and Servicing Structures and Systems" to be divided and enlarged upon. This division is possible in large-sized schools because of increased enrollment and more teachers.

"Constructing and Servicing Structures" emphasizes the construction and servicing of commercial, institutional, and residential structures. "Electro/Mechanical Systems and Servicing" deals primarily with the various mechanical, electrical, and electronic systems commonly found in commercial, institutional, and residential structures.

COURSE TITLE

"Construction Systems" (8116) 18 weeks

(Level III - All Schools) Grade 9-10

COURSE DESCRIPTION

The Construction Systems course provides the students with a working understanding of the key elements associated with designing, planning and constructing a structure on-site. The prinicpal purpose is to have the students learn the major concepts implied in the content elements through hands-on activities, using contemporary construction tools and materials. These activities should include a variety of types of construction such as commercial and industrial buildings, bridges, and pipelines. Emphasis should be on student understanding of all the major concepts associated with each of the major content elements as well as interrelationship of all of the management and production elements. For example, time restrictions will limit the selection and number of activities in each element. Consequently, it is important that the instructor not lose sight of the total input - process - output model of a complete construction system.

COURSE OBJECTIVES:

This course will enable the student to do the following:

1. Relate construction technology to the broader context of industry and technology.
2. Perform selected management practices in planning, directing, and controlling as they relate to construction production systems.
3. Perform selected industrial relations practices as they relate to a managed production system in construction.
4. Appreciate, understand, and perform selected production and servicing practices as they apply to construction products.
5. Understand the interrelationships within and between construction,

COURSE OBJECTIVES (continued)

the environment, individuals, and society.

6. Appreciate and have some understanding of constructed projects and the tools and materials utilized in their construction.
7. Develop an awareness of careers in construction technology.
8. Develop an awareness of the significance of construction industry and technology in the past, present, and future.
9. Develop responsible and safe work attitudes and the ability to function as a member of a group.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Research and Development Process - Initiating the project - Developing the project * Designing * Engineering -Implementing	Complete a simple construction design problem, e.g. shelter for bus riders, tool shed, animal shelter, playhouse.	12%
Preparing the Site - Clearing the site - Surveying for construction - Earthworking	Identify a site, determine obstacles to be removed, determine the best way to remove the obstacles and locate a structure on a site using surveying instruments.	4%
Building the structure - Setting the foundation - Building the major structural elements Installing Utility systems (E.G. electrical, plumbing, communication, HVAC, transportation) - Installing permanent utilities and mechanical plant - Providing temporary equipment	Construct modules which are representative of the primary outputs of construction. e.g. Residential buildings, commercial buildings, pipelines, and bridges. Management of site work will be integrated into these activities, and provide attention to cost, materials and time. Laboratory activities should include experience with actual construction tools and materials appropriate for each content element.	70%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
(continued) Enclosing the structure (rough finishing) - Preparing materials - Handling materials and components - Assembling in place Finishing the Structure (fine finishing) - Preparing subsurfaces - Preparing materials - Handling materials - Trimming - Removing Equipment and Debris Planning - Formulating - Supplying - Scheduling - Routing - Storing Organizing - Structuring - Supplying - Scheduling - Routing - Storing		

CONTENT	REPRESENTATIVE ACTIVITES	TIME
(continued) Controlling - Monitoring - Reporting - Correcting		
Completing the site - Landscaping - Building features - Shaping and finishing earth	Select a site and identify the steps which must be completed.	2%
Servicing the project - Diagnosing/troubleshooting - Repairing - Altering - Installing - Maintaining	Complete selected maintenance and repair activities to module, home or simulator.	12%

COURSE TITLE

"Structures and Systems" (8155) 18 weeks

(Level IV Small and Medium Schools) Grades 11-12

*ALSO SEE THE LARGE SCHOOL CONFIGURATION FOR STRUCTURES AND SYSTEMS FOR ADDITIONAL ACTIVITIES.

COURSE DESCRIPTION

This course includes the construction practices basic to the erection of commercial, institutional, and residential structures and the installation of mechanical and electrical systems within these structures. Students assume the role of subcontractor and manage the work of their classmates for a portion of the module construction. At other times they are working as a member of another subcontracting crew. Work begins with the foundation. The structural system is erected. The mechanical and electrical systems are installed. Finally the structure is enclosed and finished. Inspections are conducted at appropriate intervals and the necessary service work is performed. Near the end of the course selected maintenance and repair problems are simulated and the service work is completed.

COURSE OBJECTIVES:

1. Perform selected production practices related to building structures and installing mechanical and electrical systems.
2. Perform selected management practices in planning, organizing, directing, and controlling as they apply to building construction.
3. Understand the interrelationships within and between management and production practices as they relate to constructing and servicing structures, mechanical and electrical systems.
4. Appreciate and analyze the use of tools as they relate to building construction.
5. Explore career opportunities related to constructing structures

COURSE OBJECTIVES (continued)

installing electrical and mechanical systems, and providing services to these construction products.

6. Develop responsible and safe work attitudes and practices.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Building the Structure	Introduce modules representative of residential and commercial construction which will be used as the focus of class activity for most of the semester. Practice reading drawings and specifications.	2%
Procuring - Subcontracting Employing - Specifying work rules - Selecting personnel Purchasing - Ordering - Checking Leasing Obtaining licenses, permits, and authorizations.	Organize the class such that each student has a subcontract for some portion of the work on one of the modules. This student will serve as the "contractor" for this part of the work. Prepare lists of materials required to complete each sub-contract. Obtain permits and materials. Organize work crews.	6%
Organizing - Scheduling - Routing	Schedule the sequence of processes for constructing each of the modules.	2%
Setting foundations - Making and placing forms - Setting reinforcement - Preparing foundation materials	Assemble prefabricated concrete forms for module foundations. Fabricate and place rebar. Mix, place, and finish concrete foundation.	4%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Handling materials - Curing - Removing forms	Remove forms	
Controlling - Monitoring - Reporting - Correcting	Inspect structural, electrical, plumbing, and HVAC systems at appropriate intervals. Apply appropriate servicing practices to insure that quality standards are met.	2%
Building the major structural elements - Preparing materials * Layout * Cutting - Fabricating components and temporary forms - Setting reinforcement - Handling materials and components * Transferring * Positioning * Assembling	Assembling the floor, wall, and roof structure. Note: At least some of these components would need to be prefabricated to insure that the module can be completed in the available time, e.g. wall sections or roof trusses.	26%
Introduce mechanical and electrical systems - Heating/ventilating/air conditioning	Tour the utility rooms/facilities in the school to investigate where these systems are located. How they operate, what basic components are included, and the typical inspection and service requirements.	4%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
(continued) - Plumbing - Transportation (elevators, conveyors, etc.) - Electrical power - Electronic communications		
Installing electrical/electronic systems - Reading schematic drawings - Service connection - Safety Installing circulating systems - Installing permanent utilities and mechanical plant * Preparing materials & components * Handling materials & equipment * Fastening in place * Connecting & joining - Providing temporary equipment	Each of the modules will simulate a different type of room. The electrical/electronic circuitry necessary to serve each of these rooms will be installed. For example, one module may be equipped as an office, a second as a bathroom, the third could be a kitchen, and a fourth may be a laundry room. NOTE: These production practices/processes will be applied repeatedly as each of the systems is installed and serviced.	6%
Installing heating systems Basic Types: - Steam - Forced air - Hot water - Radiant panel - Solar (active)	Each module may be assumed to have a different type of heating system, e.g. hot water, baseboard, electric or steam. NOTE: Students would assemble prefabricated components to install these systems. Same production practices as listed above.	4%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Plumbing systems Basic types: - Water supply - Sanitary sewer - Storm sewer * Installation of circulatory systems	The appropriate plumbing system will be installed for each of the modules. This will include rough-in and fixture installation. Same production practices as listed above.	4%
Enclosing the structure - Preparing the materials - Handling materials and equipment - Assembling in place Finishing the structure - Preparing subsurfaces - Preparing materials - Handling materials - Trimming - Removing equipment and debris	Interior and exterior wall surfaces will be enclosed and appropriate finish materials applied. This work will be "sub-contracted".	22%
Completing the site - Landscaping - Building features	Students will review landscaping plans for several different types of structures and identify the processes required to carry out one or more of the plans.	2%

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CONTENT	REPRESENTATIVE ACTIVITES	TIME
(continued) - Shaping and finishing the earth - Removing landscaping equipment and debris		
Industrial relations - Hiring - Training - Providing benefits - Providing career options	Each student "contractor" will be responsible to "hire" a crew to complete the work required by his/her subcontract. NOTE: Also, a series of activities interspersed in the class will provide students with the opportunities to better understand how labor relations are conducted within the construction industry.	6%
Servicing the project - Diagnosing/troubleshooting - Repairing - Altering - Installing _ Maintaining	Complete selected service activities to the module or simulators.	10%

COURSE TITLE

"Construction Planning and Design" (8146) 18 weeks

(Level IV Medium and Large schools) Grades 11-12

COURSE DESCRIPTION

Construction Planning develops the students' understanding of the practices involved in initiating, designing, financing, and engineering constructed works. To capture student interest and provide some perspective for the remainder of the courses, the student is first introduced to the future of construction. This is followed by an analysis of the impact construction has on our environment, and how our man-made environment came to be.

COURSE OBJECTIVES:

This course will enable the student to do the following:

1. Appreciate, understand and apply the construction design process.
2. Understand the interrelationships between construction technology and community development.
3. Develop an awareness of the significance of construction technology in the past, present and future.
4. Appreciate and understand selected production and management practices as they apply to the construction system.
5. Appreciate and understand the interrelationships within and between management and production practices in the construction system.
6. Explore career opportunities in the planning phase of construction technology.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Future of construction	Have student identify examples of innovative construction projects.	2%
Impacts of construction	Using examples of construction projects students will examine factors such as construction costs, environmental concerns, functional design, aesthetics, and maintenance and operating expenses.	11%
Introduction to technical processes, materials, and equipment including a historical perspective: - Basics of structural systems: * Types * Characteristics * Materials employed - Mechanical systems in the structure: * Water supply * Drain, waste and vent * Storm-water disposal * Ventilating, heating and cooling - Electrical system - Construction methods: * Joining various materials * Erection techniques NOTE: This content would be integrated into the study of design and engineering of a structure.	Activities could include identifying tools and materials and their applications.	11%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Regulatory and economic considerations	Examine the pros and cons of a current community problem involving the construction of a proposed project.	6%
Research and development process - Initiating the project * Formulating - Determining objectives * Stating goals * Consulting * Establishing project criteria * Evaluating * Describing objectives - Researching * Locating data * Retrieving data * Describing data o Drawing o Reporting o Classifying-Categorizing o Defining * Evaluating data o Comparing o Contrasting o Measuring against criteria o Rating * Forecasting	Begin the design of a construction project that will continue throughout entire course. Students should work in design teams, and the problems should include a variety of construction projects, i.e., commercial, industrial, residential, bridges, highways, and airports.	6%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Administering the project - Directing * Coordinating * Assigning * Supervising * Redefining Project programming - Evaluating * Analyzing data * Comparing * Contrasting - Selecting * Examining * Eliminating * Adapting * Adopting - Presenting * Scheduling * Diagraming * Reporting * Demonstrating * Summarizing	Activities should focus on team management in the design and engineering of the construction project.	2%
Financing the project		

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Financing the project (continued) - Appraising property - Estimating probable cost - Funding - Documenting - Budgeting	Estimate probable costs based on tabled values for various types of construction.	4%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Developing the project - Designing * Evaluating concepts - Evaluating the program - Determining the functional responsibilities * Postulating solutions - Scaling functional relationships - Presenting solutions * Selecting a solution - Analyzing alternative solutions - Appraising alternative solutions - Evaluating alternative solutions	Present and critique alternative solutions	6%
Engineering - Interpreting drawings & reports - Establishing detailed design criteria and standards - Analyzing problems - proposal * Grouping * Classifying * Identifying - Estimating sizes - capacities * Referring * Comparing	Each team should complete design drawings and a model with sufficient detail for presentation to a prospective client.	43%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Engineering (continued) * Approximating - Detail designing * Standardizing		

CONTENT	REPRESENTATIVE ACTIVITES	TIME
* Computing - Calculating - Calibrating - Appraising * Experimenting - Modeling - Building prototypes - Testing * Preparing working drawings - Scaling - Dimensioning - Notating - Referencing and titling * Securing approval - Inspecting _ Authorizing		
- Specifying * Preparing outline specifications * Drafting final specifications	Prepare sample specifications for major elements of the construction project.	6%
Implementing - Contracting - Construction programming - Procuring - Supervising construction	Design team interface with contractor and client in preparation for construction with emphasis on such concepts as: 1. Types of contracts 2. Sub-contracting 3. Estimating and bidding	

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Implementing (continued)	4. Financing 5. Bonding 6. Responsibilities of client, designer and contractor 7. Inspection	3%

COURSE TITLE

"STRUCTURES AND SYSTEMS" (8155) 18 weeks

(Level IV Large Schools) Grade 11-12

COURSE DESCRIPTION

Structures and Systems places emphasis on the practices employed to construct and service commercial, residential and institutional structures. First, the students study how the site is cleared, the structure designed, and the excavation completed. At this point, students are divided into groups for the purpose of constructing modules or small structures representative of commercial and residential construction. Activities also include servicing experiences to alter, repair and maintain the project. Students will learn to read drawings, "take-off" lists of materials required, schedule the construction sequence, and account for costs involved.

COURSE OBJECTIVES:

This course will enable the student to do the following:

1. Perform selected production practices in preparing the site, building the structure and servicing as they apply to building construction production systems.
2. Perform selected management practices in planning, organizing, directing, and controlling as they relate to building construction production systems.
3. Understand the interrelationships within and between management and production practices as they relate to constructing and servicing structures.

COURSE OBJECTIVES (continued)

4. Appreciate and analyze the utilization of tools and materials in constructing and servicing structures.
5. Explore career opportunities related to construction and servicing structures.
6. Develop responsible and safe work attitudes and practices.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Preparing the site - Clearing the site * Providing temporary access and protection * Reducing obstacles * Handling materials - Setting of temporary facilities - Surveying for construction * Referencing to existing features	Establish batten boards for a given site using conventional surveying instruments.	3%
Earthworking - Mobilizing equipment - Earthmoving - Protecting existing utilities and structures - Shaping and stabilizing earthworks	Given a typical excavation problem determine: - Excavation method - Volume of earth to be moved - Sequence of operations - Protection for existing utilities and structures	4%
Building the structure	Introduction of modules or small structure(s) which will be used as a focus for class activity for most of the semester. Practice reading drawings and specifications.	2%
Procuring - Subcontracting	Prepare a list of materials needed to complete the project.	3%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
(continued) Employing - Specifying work rules - Notifying prospective employers - Selected personnel Purchasing - Writing detailed specifications - Ordering - Checking - Claiming Leasing Obtaining licenses, permits and authorization	Obtain materials, permits, and organize work crew.	
Organizing - Scheduling - Routing	Schedule the sequence of construction using a CPM method.	2%
Setting foundation - Making and placing forms * Building forms * Assembling in place * Treating forms	Build forms for foundation or complete other similar concrete work.	2%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Setting reinforcement * Cleaning and shaping * Transferring and placing * Supporting	Setting reinforcement for foundation	1%
Preparing foundation materials * Treating * Proportioning and batching * Mixing - Handling materials * Transferring * Placing * Consolidating * Building-in inserts, anchors, ties, and hangers * Finishing - Bonding * Preparing surfaces * Joining - Curing * Controlling moisture - Removing forms - Finishing foundations	Mixing, placing, and finishing concrete for foundation. Form removal.	3%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Controlling - Monitoring - Reporting - Correcting	Inspection of building at appropriate intervals.	2%
Building the major structural elements - Preparing materials * Layout * Cutting - Fabricating components and temporary forms - Setting reinforcement - Handling materials and components * Transferring - Hoisting - Carrying * Positioning - Locating - Bracing and holding - Aligning - Placing * Assembling - Fastening - Bonding	Building the floor, wall, and roof structural systems.	16%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Enclosing the structure - Preparing the materials * Laying out * Cutting * Forming * Mixing * Making temporary form work * Fabricating components * Treating - Handling materials and equipment - Assembling in-place Finishing the structure - Preparing subsurfaces - Preparing materials - Handling materials - Trimming - Removing equipment and debris	Complete exterior and interior of structure.	35%
Completing the site - Landscaping * Building accesses - Building features	Sketch a landscape plan for the structure.	3%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
-Shaping and finishing the earth * Layout * Earthmoving * Preparing the surface * Planting and surfacing -Removing landscaping equipment and debris		
Industrial relations - Hiring - Training - Providing benefits - Providing career options	A series of activities will be interposed in the class time devoted to building the structure to illustrate typical occurances which highlight industrial relations practices. Such activities might include: -Jurisdictional concerns - Improper working conditions (this could be related to laboratory clean-up) - Joint trusteeships - Hiring hall - Apprenticeship program - Non-union employment	8%
Servicing the project - Diagnosing/troubleshooting - Repairing - Replacing - Adjusting - Testing - Disposing	Complete selected service activities to the module structure, house, or simulator.	16%

COURSE TITLE

"Electro/Mechanical Systems and Servicing" (8156) 18 weeks

(Level IV Large schools) Grades 11-12

COURSE DESCRIPTION

This course includes an introduction to the various mechanical, electrical, and electronic systems in residential, commercial and industrial structures. Basic electrical/electronic theory and a study of scientific principles applied to specific mechanical systems will be included throughout the course. Basic consumer knowledge, and the ability to make minor alterations and provide service to common mechanical systems and electrical/electronic components will also be included.

COURSE OBJECTIVES:

This course will enable the student to do the following:

1. Perform selected construction practices in installing and servicing electrical and mechanical construction systems.
2. Perform selected management practices; planning, organizing, directing, and controlling as they apply to the installation, assembly and troubleshooting of mechanical and electrical systems within the construction production process.
3. Understand the interrelationships within and among management and production practices as they apply to the installation, assembly and troubleshooting of mechanical and electrical systems.
4. Analyze the utilization of tools, materials and diagrams as they relate to the installation, assembly and servicing of mechanical and electrical systems.

COURSE OBJECTIVES (continued)

5. Explore career opportunities in technologies related to mechanical and electrical systems.
6. Develop responsible and safe work attitudes and practices as they are utilized in construction production technology.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Introduction to mechanical electrical systems - Heating/ventilating/air-conditioning - Plumbing - Transportation - Electrical generating and distributing systems - Power generation and distribution - Electronic transmission	Tour heating and ventilating equipment room, elevator shaft and investigate plumbing system of the school for the purpose of identifying basic components of the mechanical system, analyzing the functions of each system and learning about the typical service and inspection requirements. Tour of an electrical generating and distribution system. Develop map of electrical distribution for your community.	3%
Basic theory of mechanical systems: - Fluidics - Hydraulics - Thermodynamics - Convection - Heat Loss - Conductance	Selected lab activities to introduce each concept needed to perform the required work.	5%
Materials and tools used to install mechanical systems: - Piping materials - Duct work	Selected activities in layout, cutting, joining, and testing practices for each of the materials should be introduced and integrated into the total course.	10%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Basic electrical theory: - What is electricity? - Measuring electricity - Components of a circuit - Types of circuits	Build, measure and troubleshoot basic kinds of circuits.	9%
Standard electrical components: - Distribution panels - Outlets - Switches - Fixtures - Meter Loop - Weather proofing - Cable types	Some of this information will be incorporated in lessons as the students begin to use the materials to perform the simulated installation of an electrical system. Tour: Equipment room of the school for the purpose of identifying basic components and analyzing the functions of the system.	3%
Installing electrical/electronic systems: - Electrical system design - Schematic drawing - Circuit calculations - Service connection - Safety Installing circulatory systems - Installing permanent utilities and mechanical plant * Preparing materials & components * Handling materials	Simulators will be used to permit students to install and service typical residential, commercial and industrial systems. NOTE: These production processes will be applied repeatedly as each of the systems is installed and serviced.	18%

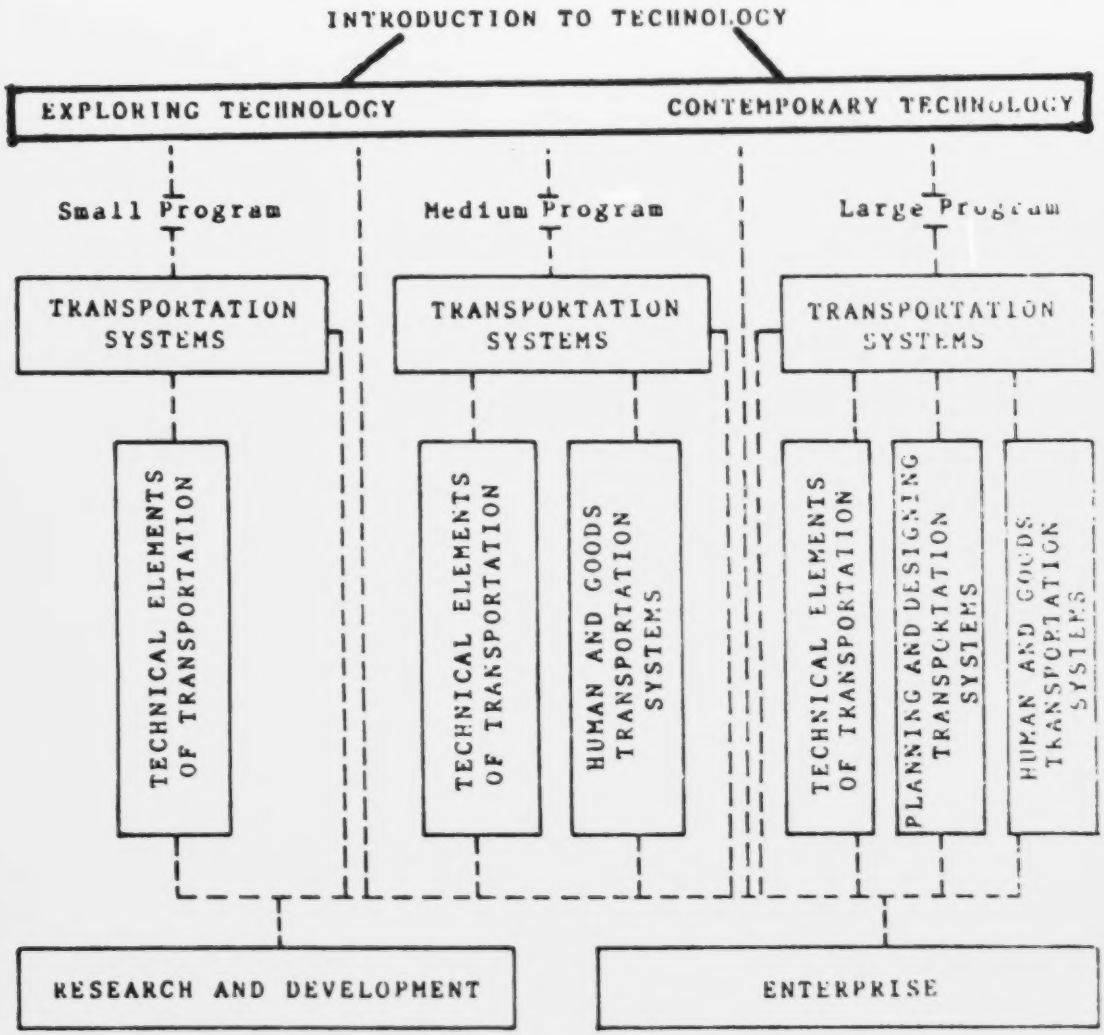
CONTENT	REPRESENTATIVE ACTIVITES	TIME
* Fastening in place * Connecting and joining - Providing temporary equipment		
Industrial relations: - Hiring - Training - Providing benefits - Providing career opportunities	A series of activities interspersed in this course to illustrate how these practices are carried out in the construction industry. Such activities might include: - Role playing hiring procedures - Discussion of training requirements and opportunities in the mechanical and electrical construction industry.	6%
Consumerism:	Activities should include experience in: - Safe use of electrical power - Cost effective application of electrical power - Purchase of electrical/electronic equipment - Meter reading	6%
Heating systems - Basic types * Steam * Forced air * Hot and chilled water * Radiant panel - Insulation - Instrumentation - Codes	Assemble and experiment with mock-up of the basic types of hearing systems. - Troubleshooting and servicing activities simulated with mock-up. - Mock-up of steam, forced air and hot water heating system. - Gauges and meters required to evaluate systems.	10%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Installing circulatory systems * Installing permanent utilities and mechanical plant * Providing temporary equipment		
Ventilation and pollution control systems - Types - Designs - Basic components - Controls - Safety devices - Installation - Troubleshooting - Service - Codes	Using forced-air duct system, experiment with ventilating problems and system servicing.	7%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Air-conditioning systems - Design - Components - Installation - Troubleshooting - Service	Selected activities should include: - Basic installation procedures of air-conditioning systems - Basic troubleshooting based on actual or simulated system malfunctions	5%
Plumbing systems - Types - Design - Components - Installation - Inspection - Service	Selected activities should include: - Basic installation procedures of a typical plumbing system for a two story commercial building. - Complete testing and inspection of a simulated plumbing system. - Trace plumbing system throughout a given structure.	15%
Other mechanical systems - Fire and sprinkler systems - Lawn sprinkler and irrigation - Gas piping - Swimming pool filtration - Solar heating - Elevators/conveyors	Using simulation operate, test and service a minimum of one system.	3%

TRANSPORTATION COURSES

*(INTEGRATED TECHNOLOGY)



*NOTE: WHILE THIS IS A PART OF THE SCOPE FOR INDUSTRIAL ARTS/ TECHNOLOGY EDUCATION, EXPENDITURES FROM VOCATIONAL FUNDS ARE RESTRICTED TO GRADES 7 - 12.

INTRODUCTION TO TRANSPORTATION

The following course guidelines have been developed to assist technology education teachers to introduce a transportation area into their curriculum. The courses reflect transportation as a new area of content and an expanding mission within technology education. This does not indicate that all of what is being done in the classes is wrong. It does suggest that curriculum expansion is needed to adequately present the geometrically expanding nature of technology--our content base.

This view suggests that the areas of power, power mechanics and energy areas taught in many programs are subsets to the larger and more complex content area of transportation. As an example of how these areas differ from one another, we may examine a specific content focus such as the rear axle assembly of an automobile. In power mechanics, gearing theory, lubricants, friction coefficients, hydraulics, and other technical elements may be studied. In transportation, however, these concepts are studied along with historical developments, technical problems, bevel vs hypoid type differentials and their relationships to vehicle center of gravity, vehicle speeds, road designs, social implications of the super highway, social and economic implications of road layout and design, etc.

Expansion of the curriculum is the proper way to view transportation classes. The mission is one of technological literacy using transportation as a vehicle to examine the past, present and future tendencies of the field. This goal

must be seen differently than the technical literacy emphasis of power, power mechanics and energy classes. The technological literacy goal of transportation includes technical literacy with additional emphasis on the use and impact of transportation technology by and on society.

The courses that follow were developed to help students to become technologically literate. These courses were developed for different sized programs--small, medium and large. Course selection for small programs centered around those concepts, which were fundamental to an understanding of transportation technology. It is imperative, therefore, that a program with limited enrollment be designed using the small program model. If this requirement is circumvented, knowledge gaps could develop at the advanced course levels. These knowledge gaps will impede a student's ability to synthesize advanced level concepts (or to see the total picture). Likewise, the medium-sized model should be used in developing courses for the appropriate technology education enrollment level.

Finally, as stated in the preface, this document was designed as a guide for curriculum development and NOT as a rigid plan. Transportation technology concepts were first identified, then content to develop these concepts was selected. Representative activities were developed around this content. The concepts and activities are, therefore, intimately related. If activities are changed for any reason, the replacement activity must do all that the original activity was designed to do. Activity alteration or deletion is appropriate only as long as content/concept compatability exists.

The suggested sequence of transportation courses that is outlined for each program size will be a highly effective part of a contemporary technology education program. If used properly, the courses will help to develop technological literacy for all students.

COURSE TITLE

"Transportation Systems" (8126) 18 weeks

(Level III All sized schools) Grades 9-10

COURSE DESCRIPTION

A conceptualized study of transportation systems dealing generally with the methods by which we move people and goods through various environments. The environments studied will be terrestrial, marine, atmospheric, and spatial with selected content from each in a past, contemporary and futuristic perspective.

COURSE OBJECTIVES:

1. To develop in each student an awareness of the need and function of transportation in society.
2. To develop a depth of understanding into the technical, social and environmental aspects of transportation systems.
3. To develop technical problem solving abilities and creative talents using the transportation of goods, materials and people as a central theme.
4. To provide students with an enjoyable experience in the study of technology using transportation systems as a content focus.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Discovering Transportation - Movement of people and goods and how this need has changed over time * Energy - Simple - Complex * Man's past versus present and future transportation needs.	Graph forms of energy. List energy inputs to transportation systems in the past. List energy inputs to transportation systems in the present and future. Have students examine transportation systems and look up their accepted energy efficiencies. Film on oil exploration. Film on oil refinement. Problem Solving Activity: Students are faced with the problem of moving 5 lbs. of solid material from a tabletop to the floor and back again. Use distance of 10 feet of floor spacing. Although time is not a problem, energy input is. You must use only simple forms of energy input to do this job, build this system and make it function well.	10%
- Managing Transportation Systems * Management of Simple Systems * Management of Complex Systems - Maintenance - Goods Input Control - Goods Output Control - Goods Output Scheduling	Develop a semi-automated loading and unloading system for the bulk material moving system previously designed. List the changes that would be necessary on the goods' moving system to make it suitable for people to use.	10%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
* People-Oriented Systems - seats - environment control - special loading facilities - special unloading facilities	Invite a person from a local transportation industry to your classroom to discuss the problem of scheduling, route designation, fare evaluation, bills of lading, workers' skill requirements, maintenance, etc. This activity should expose students to the complex problems faced by the management personnel responsible for the operation of modern transportation systems.	
A general Introduction to the Environmental Mediums and Modes of Transportation Systems - Terrestrial * Road Transportation Systems - early road systems - Toll roads - the cost of roads - safety on the roads	List the various types of transportation systems that require roads in order to operate. Using a state, county and/or city map, examine the road systems in your area. Find out who pays for these roads to be built and maintained. Find the closest toll road to your school. Find out where the money from this route goes. Have a policeman visit your class and talk about the problems faced by law enforcement officials in keeping the roads safe and orderly.	10%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
	Major Activities: Each group of four students should examine an automobile and a bicycle. Do this at separate times. List the six technical sub-systems of the automobile and the bicycle and compare them for similarities as well as differences. Examine more carefully the arresting portion of the control system for each vehicle. Identify the arresting portion of the control system for each vehicle. List the most significant technical differences between these systems, and explain why they could not easily be interchanged.	
* Rail Transportation Systems - Right-of-Way Construction - Obtaining of Right-of-Way - Rail Transport in America - Train Control Systems	Examine a map of the United States with all the major rail lines listed on it. Determine the factors that have caused railroad rights-of-way to be located where they are. Find out why your town does or does not have a rail line. Show a film available from the Advertising Department of General Railway Signal of Rochester, New York, entitled The Railroad Signal. Discuss the major advantages of fully interlocking block signal systems. A walk along a block of a real road pointing out roadbed construction, rail insulation, etc., would be most appropriate.	7%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
* Pipeline Systems - Construction - Study of Commodities - Shipped by Pipe - Pipelines in America - Operating a Pipeline System	Mark a United States map with the major pipeline routes in this country. Furthermore, identify commodities shipped by these routes. Build a pipeline from ½" PVC pipe that has at least three 90 bends in it and travels a total distance of about 15 feet. Using pitch changes in line and a constant feed column height, check pressures along the line. With the above system, operate it as a slurry line varying liquid (specific gravities) and solids (size and specific gravity). Measure liquid and solid volumes at varying slopes with various fluids, and find an optimum combination.	10%
- Marine * Inland - Commodities - System Operation - Navigation	Identify the major inland water routes in the Continental United States, and name six commodities that are shipped by these routes. Build a scale model of a river barge. (Scale ½" x 1'). Build it to carry 9 lbs. of sand. Consider minimum channel depth of 15 feet. To scale, this is only 7½" of water. Build the barge so that you always have a 1 foot channel clearance. Build a model of an actual inland water-way with channel markers, navigation lights and a functioning lock.	10%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
* Transoceanic - Commodities - Navigation	List five commodities available for purchase in your town that most likely came from foreign countries by ship. Also, find out the packaging techniques that were probably used to ship these items. Build a model of a cargo container. Look up and discuss the methods used in transoceanic navigation.	5%
- Atmospheric * Lighter-Than-Air Systems - Wind Current Navigation - Maintaining Buoyancy - Control of Lighter-Than Air Craft	Define lighter-than-air craft and heavier-than air craft. Describe the major differences and major features of lift and control systems for each. Construct a hot air balloon and fly it. From your experiences with this activity, draw some conclusions about safety of operation and the control of lighter-than-air craft.	10%
* Heavier-Than-Air Systems - Navigation Systems - Physical Flight Systems - Ground Support Systems - Federal Aviation Administration	Plot a course on a low altitude sectional chart. Construct an airport with runways, taxiways etc. Show concern with detail. Model an actual airport. Visit an airport on flight service station. Invite a Fixed Base Operator or an FAA Official to speak to your class. (continued next page)	

CONTENT	REPRESENTATIVE ACTIVITES	TIME
	Invite an airline official to speak to your class about the problems of operating a passenger and cargo transporting airline.	
- Spatial * Navigation Systems * Manned Spacecraft * Unmanned Spacecraft * Support Systems	Show a film on space navigation. Ask an astronaut to speak to your class about his experiences in space. Build a model rocket and fly it. Examine and discuss the various types of facilities needed to launch and retrieve space vehicles.	18%

COURSE TITLE

"Technical Elements of Transportation" (8176) 18 weeks

(Level IV all-sized schools) Grade 11-12

COURSE DESCRIPTION

A study of the technical elements that make up contemporary, complex transportation systems. The actual methods by which movement is produced, guided, directed, and controlled will be studied. Both the discovery learning and directed research approach will be used to guide the learning processes in this course.

COURSE OBJECTIVES:

1. To familiarize students with the technical means by which humans accomplish the acts of transporting.
2. To provide students with an opportunity to work with actual components commonly found in transportation systems.
3. To develop a general appreciation for the highly technical and complex nature of transportation technology.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Propulsion Systems - Horsepower Calculations	Set up a simple experiment in the classroom where students move material in a specific amount of time. Have them calculate horsepower values for their efforts. (competition encouraged) Major Acitivity: Test various engines and fuels doing dynamometer tests. Depending on how sophisticated you want to be, you may conduct thermal analysis tests measuring air and fuel ratios with horsepower output, etc. Emmissions tests may also be conducted to draw parallels between specific energy type, systems, efficiencies, and pollutants.	10%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Energy Converters - Internal Combustion	Conduct specific gravity tests on various fuels and calculate their weight per unit volume and energy capacity per unit volume. Using a basic automobile efficiency figure, calculate fuel tank sizes for given tank/mileage requirements. Also predict BTU/lb. volumes of specific fuels from specific gravity figures. Disassemble, clean, inspect, and reassemble a 4-stroke cycle engine in groups of 4 students each. Disassemble and inspect a 2-stroke cycle engine, and involve students in a discussion of the advantages and disadvantages of 2-stroke over 4-stroke cycle engines.	10%
- External Combustion	Build from kits small reciprocating steam engines. (high pressure type) Collapse a can using heat and steam. Discuss the operating principles of the atmospheric steam engine. Discuss the concept of vapor pressure, and use a can of Freon to demonstrate the advantages of using flourocarbons as a working fluid in expansible-chamber gas engines. Build a small boiler and also a simple turbine blade. Use an electronic tachometer to monitor speed. You may even want to build a small dynamometer to test horsepower output.	10%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Electrical	Build a simple primary and a simple secondary cell. Have students explain thoroughly the differences between these two units. Build a small electric motor from paper clips and enameled wire. Remove battery pack from a spent film cartridge for a modern polaroid camera. Solder a light bulb to the terminals and calculate energy wasted in throwing the battery pack away after the film is used. Base data on length of time the bulb stays lit.	5%
Drive Systems - Mechanical	Using either teacher-created or purchased experimenter kits, study the field of gearing theory through experimentation. Disassemble and study the rear axle assembly of an automobile. Do this as a group.	10%
- Hydraulic	Discuss basic fluid power applications for drive systems. You could demonstrate the principles of hydraulic motors using either a test bench, or you could create your own testing system.	

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Air Suspension Systems - Water Suspension Systems - Magnetic Suspension Systems	Using an air bearing system with either compressed air or even a vacuum cleaner as a pressure supply, build an air cushion support system. Study the advantages of air cushions in transportation systems. Build test gliders. Use airfoil design as the major variable. Study the present applications of hydrofoil technology. You might build a water sluice with various designs of foils and test lift. Build permanent and electromagnetic lift systems. Check weight versus energy input in each system.	
Control Systems - Arresting	Study and compare the flaps of an aircraft with the brakes of a car and the rudder system of a boat. Laboratory equipment to conduct this comparison could be built. In fact, for the airfoil, one might use the wind tunnel previously built to study induced drag. Examine and discuss the arresting systems on a number of common transport systems. Do some hydraulic calculations using the F = PA equation, and study its relationship to stopping a vehicle.	10%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Hybrid Drive Systems - Drivetrain Maintenance	Disassemble, inspect and reassemble a simple 2-speed automatic transmission from an automobile. Do this as a class and perform calculations on force, area, clutch size, speedometer drive gear ratios, and any number of similar activities. Have a service manager from a local automotive agency come and speak to your class about new types of transmission and drive systems being used for automotive applications.	
Suspension Systems - Mechanical Suspension - Fluid Suspension * Air Suspension Systems	List advantages and disadvantages of various types of wheel suspension transportation systems. Study the construction of bias ply and radial tires by having students cut apart various types of tires. A research report should also be conducted with this activity. Study flanged rail wheel systems using model railroad cars of the "S" gauge-type for examples. Build a small wind tunnel and study the various aspects of airfoil technology.	12%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Directional - System Control	Build a small boat and study how a rudder system works. Study aileron and rudder operation with regard to model gliders. Have an individual from a transportation industry talk about the problems of controlling the operation of the transportation system with which he or she is associated.	
Guidance Systems - Guideway	Study and compare the unique differences between highway, rail, tube, canal, cable, and monorail systems. Divide the class into groups and have each group build a guideway like one of those discussed. Build a tube flight transportation system. Use a .020 model aircraft engine with 3-3/4" prop fixed to a wooden dowel. Fly in P.V.C. tube or old rug tube. Work on turns as a problem solving activity. Also, attitude adjustment and maintenance for problem solving. Study early canal systems and build a model of canals that move goods from one level to another.	12%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Guidance Methods and Mechanisms	Study VOR systems for air transportation. Study block signal systems for railroads by either building a model railroad system that is automatically controlled or by visiting a railroad. Develop a laboratory activity whereby a micro processor unit is used to control a model transportation system. (Even a model robot system could serve this purpose.) Study the methods of channel marking and navigating through inland waterways. Build a traffic light, study the reasons behind color selection; and, as a class, observe the flow of traffic in a place where two or three lights in sequence are involved. Ask students to identify the problems with building systems of this type that serve people efficiently.	
Structure Systems - Vehicle Structures	Build models of various frame designs for automobiles and compare them for strength and practicality. Build models of frame design for aircraft and look at the differences, similarities and advantages of each.	15%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Vehicle Structures	Study hull structure of ships and explore the physical reasons for why concrete and steel ships can be made to float in water.	
- Guideway Structures	Discuss multi-right-of-way usage and prepare a model of a transportation system in a town where road rights of way can be used by two or more transportation modes.	
	Build a model of various types of bridges. Have the class divide into groups, and ask each group to select a different type of bridge support structure to model. Compare material requirements, advantages and disadvantages of each type of structural system modeled.	
- Structural Support Systems	Build a model of a multi-modal terminal facility. Divide the class into groups and allow each group to choose different modal, interfaces; e.g., marine-truck, truck-train, remote land location-bulk, terminal-barge, etc. Study the problems common to materials handling, modes, and terminals.	

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Support Systems - Personnel	Study the various aspects of automatic fare collection systems. Examine magnetically coded tickets, study contemporary systems on which they are used, and the effects such fare collection systems have on transportation system employees. Study the types of employment opportunities available in any number of transportation industries. This may be done by students as groups, in lecture, on field trips, or any combination of the above.	6%
- Regulation	Study the makeup and authority of the following agencies: F.A.A., C.A.A.B., F.R.A., I.C.C., N.A.S.A., U.S. Coast Guard, Army Corps of Engineers, Department of Transportation, and any transportation related state agencies. Invite a state official to speak to your class on the topic of carrier regulation.	
- Operational Management	Plan a route for garbage collection in your town using a minimal spanning tree model. Emphasize how important it is to consider such things as environmental factors, economic factors and community factors in designing such a system.	

COURSE TITLE

"Planning and Designing Transportation Systems" (8185) 18 weeks

(Level IV Large Schools) Grades 11-12

COURSE DESCRIPTION

An analysis of the transportation system and its associated technologies as it relates to the urban, intercity and international needs for moving people and products. The course is designed to show the interrelationships between a transportation system and the economic, social, political, and environmental systems of a region and to illustrate that the results of all individual decisions by users and providers constitutes the demand for transportation.

COURSE OBJECTIVES:

Upon completion of the course, students should be able to:

1. Provide an understanding of the scope and role of transportation systems designed to provide mobility and accessibility based on the needs of individuals and societies.
2. Analyze the importance of transport system planning by identifying the optimal system including: (a) system objectives; (b) system constraints; (c) system inputs; (d) operational characteristics; (e) system outputs; and (f) environmental factors
3. Illustrate how transportation systems relate to the movement of products and individuals through the: (a) number and types of transportation modes and vehicles available; (b) accessibility of the networks to potential shippers, receivers or passengers; (c) operating policies of the modes, types of service offered and the economic imperatives.
4. Identify the parameters that need to be considered in the planning of transportation systems to provide: (a) adequate service, (b) minimal adverse environmental impacts and (c) efficient resource utilization.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Transportation: A Human Endeavor - Elements of Transportation * Human Mobility * Transport Activity - Journey to work - Social interaction - Recreation - Movement of goods and materials * Physical Elements - Natural Elements - People-made vehicles and structures Classification of Transportation Systems * Personalized/Private Passenger * Public Transit (Passenger) * Transport Carrier (Freight) - Common - Contract - Private - Transport Users * Consumers * Industrial * Government	Identify the needs for transportation in your own community as they relate to: - journey to work - social interaction - recreation - movement of goods and material Determine how much energy is used by your travels. Analyze the type of energy that predominates your life style, the transportation systems through which that energy is transmitted, the forms it converts into, and the ultimate benefits or drawbacks your conventional transportation patterns exact on society. Finally, determine if there is a better way for you to transport yourself. Describe that method--perhaps design the specific equipment needed to implement your plan. Then describe how it will affect all who are associated with your plan.	8%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Urban Transportation Planning Parameters - Urban Travel Demands * radial-type along corridors focusing on the central business district * circumferential travel between activities located in the suburbs * travel within residential areas. * travel within the central business district * travel to and from major activity concentrations not located within the central area, such as airports, etc.	Obtain a city or regional transportation plan in your locale and determine the type of travel demands. - Radial type - Circumferential travel - Residential travel - Central business district - Travel to and from major activity concentration	6%
Functional System Classifications * personalized (random routes: expressways, arterials, collectors, and local roadways). - automobile - motorcycle - bicycle - taxi * public transit systems - mass rapid transit-transport technologies: fixed guideway, fixed station spacing; fixed vehicle routing and fixed schedules. - personal rapid transit-technologies: fixed guideway, fixed off-line stations, fixed or flexible vehicle routing and scheduling	Visit a local public transit system to observe the operational elements involved in scheduling guideway usage, system control elements and terminal operation. Identify the type of inputs (energy, money, labor, etc.) the system requires and the approximate cost per unit mile of service. Propose a plan for reducing the cost per unit mile of service. Design a passenger compartment for a bus that is more appropriate for present service than that which presently exists. You may want to select a school bus as a model for design.	8%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- bus systems: express and demand-responsive - dual-mode systems: dual-mode transporter and dual-mode vehicles. * Stationary transport systems - elevators - moving sideways - escalators	Design a moving sidewalk. Determine where it would most appropriately be used, its traffic density factor, why it is used, and what some of the viable alternatives to it would be. Build a model of the design if time permits.	
Transportation systems operations and maintenance * Scheduling of personnel * Scheduling of vehicles * Guideway usage * Control systems * Terminal operations - automobile terminals (parking) - transit station terminals - bus terminals - rail terminals - commodity terminals/warehouses - airport terminals	Build a roundhouse and turntable for a model railroad (1930s vintage). Have students determine why roundhouses are no longer needed by modern railway systems.	8%
Urban transportation environment * Direct problems - traffic congestion - safety - environmental quality	Find a place in your town where there is a constant traffic problem (congestion, noise, pollution, accidents, etc.). Study the area and make recommendations for resolving the problem identified. If possible build models of the area before and after your recommendation are implemented.	6%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- energy costs - economic efficiency - high user cost - lack of privacy - inadequate capacity - high facility cost/low return * Indirect problems - esthetic quality - space utilization - urban growth problems - housing patterns - air pollution - level of noise - inordinate changes in land values - unequal impact upon the elderly and handicapped	Locate an area in your town which is unsightly due to transportation systems or activities. Redesign the system to make it more pleasing and at the same time functional for the user. Build a model of your design.	
Modeling of transportation systems * Projection of future regional land use variables - population - employment - land use development	Design a transportation system that will allow handicapped people access to a public transport system. (do not clarify to the students the range of handicaps to be accommodated.	5%
Intercity Transportation Planning Parameters for passenger carriers	Visit a local manufacturing plant and study its transport operations including:	5%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- business/industry - social - recreational	* raw materials received * products produced * products packaged * products shipped out	
Distribution of materials and products * raw materials to manufacturing plant * distribution of products to main station points * delivery to consumer Functional system classifications * personalized (highway) - automobile - motorcycle - trucks * Mass and bulk carriers - railway (conventional & unit trains) - trucks - pipeline - bus transit - water/marine transport - atmospheric transport * Intermodal/multi-mode systems - piggyback - pallet type train * Interfacing transport modes	Calculate the total cost of a commodity (consisting of price at origin plus transport cost) and its relationship to place utility. Select a particular transportation system (such as that of a model firm) and describe in detail how the three functions-mobility, controlled locomotion and cargo protection--are accomplished. Select a particular mode or transportation system and analyze the following components including: * containers * vehicles * way links * way interchanges * terminals and operation plan Identify three major raw materials such as coal, petroleum, limestone, etc. available in your state and determine the location and mode used to ship them in the United States.	6%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Transportation system planning and operation * highway construction & maintenance * railroad right-of-way * pipeline installation * control/guidance systems * airways and airport operation - Transport carrier operations and planning * points to be served * routes to be operated to connect the point * schedule on routes - vehicle type - accomodations - capacity - special services (tour packages, warehousing, etc.) - Intercity transportation environment * traffic density * safety * economy * energy intensiveness of modes * right-of-way land use - surface modes - air modes	Assume your parents own a large tract of land and a power company wants to build a power transmission line across your land. In this context explore the concept of "right of eminent domain" and design a power line which has the least impact on the property, (a map of the property would have to be furnished showing location of roads, streams, buildings, etc.) Using the above assumption, the class could be divided into groups with each solving a different problem: - a pipeline - a new state highway - a railroad - general aviation airport - etc.	6%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
- subsurface modes * Managing the systems		
International Transport Systems - Passenger modes * Marine * Atmospheric - Freight carriers * Marine - bulk - unit * Atmospheric	Identify a product received from overseas that is used in your community and determine the means by which it is being transported from its point of origin to where it is being consumed.	3%
Transportation System Technologies - Networks * Links * Modes * Physical travel way - terrestrial - marine - atmospheric - space - Vehicle consideration * Passenger and cargo space * Propulsion system * Guidance system	Plan and design an ideal transportation system for your city or region taking into consideration the geographical layout, population density, location of the central business district, and other high activity concentration areas such as airports, etc. Build a scale model layout of the system on a 4x8 sheet of plywood depicting each mode by its: * Guideway * Vehicles for each mode * Parking lots * Terminals/point stations * Control units * Other components	8%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
* Control systems * Structures * Suspension - Terminals/Wayside facilities * Loading and unloading area and systems * Storage area * Maintenance area and system - System control * Physical * Legal and governmental * Managerial: policy and budget		
Transport: Governmental Organization - City - County - State - Regional - National (United States Department of Transportation) * Federal Highway Administration * United States Coast Guard * Federal Railroad Administration * Federal Aviation Administration * Urban Mass Transportation Administration	- Acquire information on the various transportation governmental organization (city, state and national) and prepare organization charts for each. Also, describe the type and degree of control each agency has over the various transportation system.	5%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Transportation and the Future - Automated highways - Intercity gravity-vacuum tube transit - Multi-modal capsule systems - Electric propulsion * Linear induction motor * Battery-powered electric vehicles * Hybrid propulsion systems - Flywheel propulsion - STOL and VTOL atmospheric systems - Transportation/communication trade-offs - Space vehicle travel	Design and construct a vacuum tube transport system that employs a variable air pressure as its force producing medium Obtain a linear induction electric motor (for example an electric curtain rod) and construct a transportation system with linear induction propulsion Design and construct a hybrid "Go-Cart". Utilize a small gasoline engine and an alternator for charging a storage battery that drives a starter motor connected to the rear axle. Analyze the benefits and problems associated with this type of system.	26%

COURSE TITLE

"Human and Product Transporting Systems" (8186) 18 weeks

(Level IV Medium and Large Schools) Grades 11-12

COURSE DESCRIPTION

This course is designed to teach students the differences, as well as the similarities, between the methods of transporting goods and/or people from one point to another. It is intended to clearly point out how the nature of the commodity being shipped affects the design, route, efficiency, control, servicing, and operation of the vehicular system. As in the technical elements course, both the discovery learning and the directed research approach will be used to guide the learning process.

COURSE OBJECTIVES:

1. To familiarize the students with the variations in cost of transporting people and goods from one point to another.
2. To familiarize students with the way in which transportation systems have affected social changes and patterns in our society.
3. To familiarize students with the unique demands products place on the design and operation of transportation systems.
4. To familiarize students with some of the reasons why new technological developments actually replace old technology (even though we may love the old technology dearly).
5. To associate students with the responsibility a government has to its people with regard to their safety, welfare, economic stability, legal rights, and psychological well-being with specific regard to transportation systems.
6. To act as a synthesis level course in Industrial Arts by providing students with the opportunity to discuss contemporary, technical and social problems facing our people today; and in so doing to develop a higher level of technological literacy.
7. To force students to recognize that all technological endeavors yield positive and negative side effects.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Transportation--Routes in Conjunction with Mode, Medium and Commodity. - Water; the low cost guideway with geographic limitation. - Roads; serving the motor vehicle population. - Rail; bulk or mass movement for both people and goods. - Air; the natural guideway with no geographic limitations. - Pipelines; the high cost but high volume system for moving raw materials of certain types. - Space; the medium for unlimited travel that has most heavily taxed man's abilities with regard to control, support, guidance, propulsion, etc.	Study the inland and intercoastal waterway system in North America. Identify commodities that are shipped by water. Determine why this method of transportation is used for such commodities. Follow the entire intercoastal water system on a U.S. Map. Look up W. F. Ogburn's analysis of city growth patterns. Compare these patterns with specific cities in your area. Examine your town and try to determine how the transportation system developed. Make a proposal for a major improvement of the transportation system in your town. This improvement may be economic, environmental social, or regulatory in nature (groups by mode). Analyze your family's needs and determine (within your criteria) the most practical automobile for your family to own. Determine why your family owns the vehicle(s) it does. Furthermore, determine how cost effective that vehicle is for your parents.	20%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
	Identify the advantages and disadvantages of your family taking a vacation by airplane versus by car. Include cost and convenience and personal preferences in your analysis. Prepare a proposal for transporting people by pipeline. Include in your proposal sketches of the system you suggest along with solutions to some of the unique technical problems encountered (model may be built). (As an example of a personal capsule transport system, you may present the self-adjusting capsule elevator in the St. Louis Arch). Visit a set of railroad tracks near your school. Examine rail joints, rail flex as a train passes, block signals, rail condition, rail defects, roadbed construction, etc. Discuss the problems of moving people and goods on a rail system that looks like the one you examined. (You may use Sperry Rail Defect Manual, Sperry Rail Service, Danbury, Connecticut as a guide to analyzing rail defects, and discuss the implications of the defects you find to passenger train safety.) Draw conclusions on your observations regarding the shipment of goods versus people by rail.	

CONTENT	REPRESENTATIVE ACTIVITES	TIME
	Major Activities: On a U.S. highway map that has the Interstate Highway System, have groups of students plot the major air, rail, pipeline, and water traffic routes used by common carriers and private carriers in this country. Have each group work with one mode, (i.e.,rail, air, etc.) and identify a reason for particular route patterns as well as common commodities that follow that route. People may be viewed as a commodity, and an air flight from San Francisco to Hawaii would be a heavily traveled route. Reasons for this fact would be water surrounding the island, vacation and tourist resort, etc. In this section the concept of "value of service" versus cost of service may be explored. Citrus fruit production in Texas, Florida and Southern California to Northeast and North Central markets would be a good commodity example. Also, gulf coast oil via pipeline to the Northeast would provide another good example. Build models of specialized containers and transportation vehicles for shipping particular products. Rail refrigeration cars for berries, fruit, and corn versus hopper cars for portland cement, etc. Intermodal container design along with specialized container handling equipment may be constructed by groups in this section.	

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Transportation for place utility--industries, warehouses, airports, rail stations, and all human activities are located in certain places for certain reasons. People go to resorts for pleasure and vacations and people travel to various cities for business. Industries may locate in places that are quite remote and then provide transportation to and from that place. This section will explore, via activities, these points of interest.	Present and study Weber's theory of industrial location and his product classification system. Select an industry in your area (or any area) and have students identify all of the transportation activities needed to serve that industry. Be sure to include employee transportation systems. Also determine ways that these needs could be better met by other types of transportation systems. Study Personal Rapid Transit Systems; single purpose(people) and multi-purpose (commodity). Build a model of a PRT car that could be used for goods and/or people. Here you may model the system and integrate it in your town by planning routes, headways, blocks, and off-line-station interchanges or terminals. Show films or slides of computer controlled PRT systems and study them from many perspectives. Major Activities: Build a model of a primary processing facility (iron ore, bauxite, etc.) and study not only its operation but also the economics of bulk material shipping. Enrichment, beneficiation, commodity classification, etc., all can be integrated into this unit.	25%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Transportation Safety and Ecological Factors - Automated Control	Study the impact of the diesel engine on the railroads. Include in your study job obsolescence, safety, cost, etc. Study energy input to a number of transportation systems and compare cost effectiveness versus ecological factors for each system. Study the concept of color coding signal systems and the requirements placed on human operators when dealing with such systems. Study stability augmentation systems in aircraft and discuss how they have helped to compensate for pilot error. Major Activities: Build an automatically controlled model railroad system. Build it to the complexity of skills and resources available. Knock yourself out. You may even wish to get a microcomputer system involved with this operation. Or perhaps compare an electronic control system versus an electro-mechanical control system (good for electronics and computer experts). Build a set of color coded signals for a transportation system. You may model traffic light systems, airport tower emergency light systems, airport tower emergency light landing systems, or rail signal systems. Report to class on project and findings.	20%

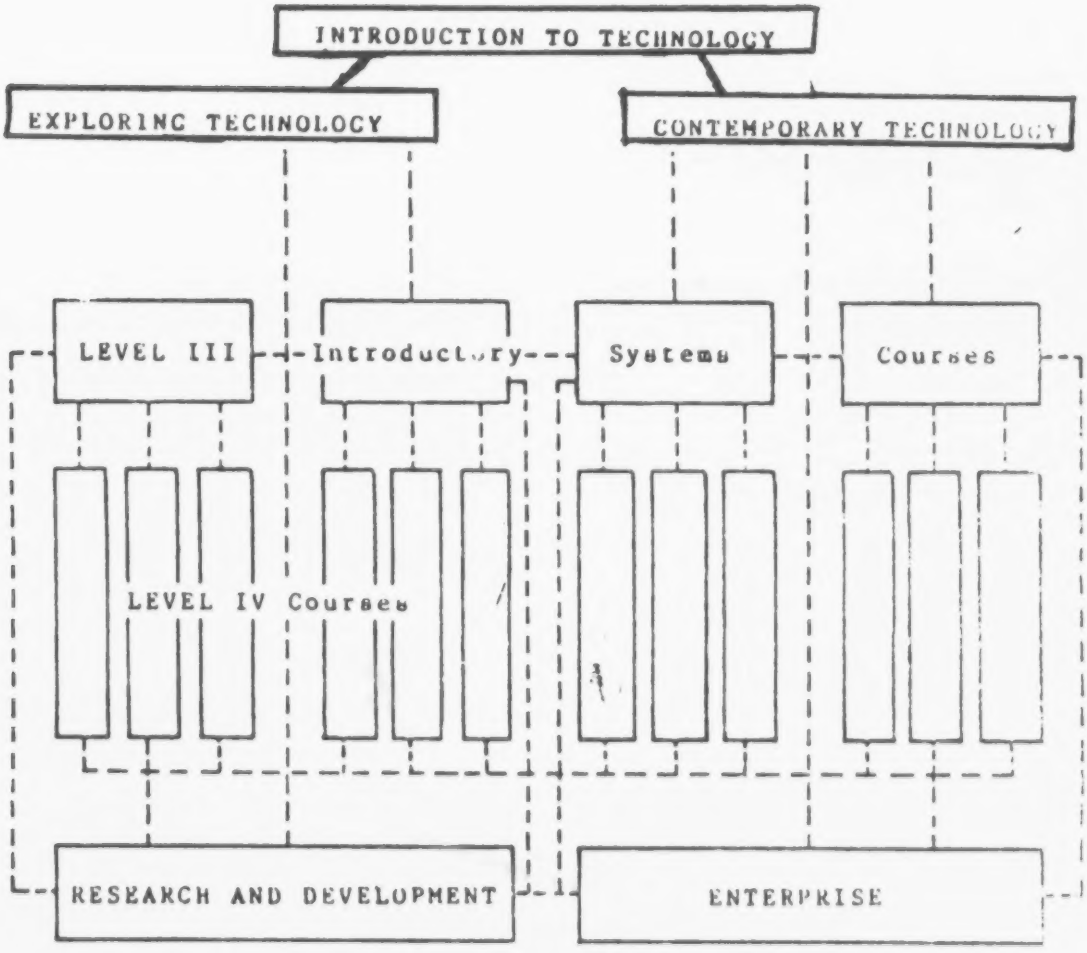
CONTENT	REPRESENTATIVE ACTIVITES	TIME
- Governmental control	Study the regulatory aspects of various government agencies over the transportation industries in this country. Look at technical, safety, environmental and economic regulation (groups by mode.) Conduct the same activity as above but concentrate on state level regulation and control.	
Transportation Vehicle Considerations--all transportation systems move goods, materials or people. Specialized containers, compartments, berthing, loading, unloading, and holding facilities are needed to accommodate the specific materials handled by each carrier. Sometimes intermodal transfer requires special handling and storage systems. The purpose of this section will be to explore the special features needed to handle people and/or goods of varying types on a variety of transportation systems. - Loading and holding facilities * bulk materials - protected - unprotected	Have students explore the types of commodities shipped by various common carriers. Study why certain products cannot be shipped in unprotected systems; e.g., portland cement, grain, etc. After exploring product requirements for shipment, have students build a model of a system for loading, moving, unloading, and storing bulk commodities. Coal, grain, sand, or any bulk commodity may be used as a content focuser. Try to use a local product. Have students look at industrial products, determine the nature of each product and an appropriate mode of shipping that commodity. Cost of service versus value of commodity should be included in this analysis. Computers, radios, baked goods, toys, and other such finished products should be researched by various groups. Have students build models of special containers to hold such commodities considering all factors including refrigeration requirements, vibration and shock limitations, atmospheric control factors, etc.	35%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
* industrial products - protected - unprotected - special * people	Any product and any mode may be used to study and model the above projects. Study the human needs that must be considered when transporting people from one point to another. Consider: noise, air temperature, air humidity, air pressure, air chemistry, lighting, food, toilet facilities, acceleration rates, and personal security factors. Any others you may wish to include should be introduced. This activity should be oriented for group discussion. Study the concept of Geosynchronous orbit and the communications satellite. Discuss the idea of moving electromagnetic waves through space as a means of communication and whether or not this is transportation or communication. Study the idea of long-range space travel and its effects on humankind; e.g., family life, personal stability, etc. Major Activities: Show NASA films on life support systems for space vehicles. Using the space shuttle as an example, you may allow students in groups to experiment with ideas about space travel and human physiological and psychological needs.	

CONTENT	REPRESENTATIVE ACTIVITES	TIME
	Moving people on a transportation system is quite different from moving products. Safety regulations are more critical and more controlled; cost of service per unit weight is much higher, generally; compartment features must be carefully controlled for temperature, humidity, noise, light, etc. For this activity, you should divide your class into groups and have each group study the unique requirements of moving people over varying distances by various modes. City bus systems, as well as commuter trains and long distance air traffic routes should be examined. Considerations for vandalism-proof interiors, long distance comfort, food, fare collection, passenger safety (hijacking, intercity safety considerations, etc.), and passenger psychological security must be considered. For example, the psychological aspects of riding in an automatically controlled high speed train or Personal Rapid Transit vehicle should be explored by various groups. Models of systems with group reports of findings should be an end to this activity.	

SYNTHESIS COURSES

*(INTEGRATED TECHNOLOGY)



---------Paths for electives. (Note the direct paths from Levels II, III and IV to the Synthesis Level courses.)

*NOTE: WHILE THIS IS A PART OF THE SCOPE FOR INDUSTRIAL ARTS/TECHNOLOGY EDUCATION, EXPENDITURES FROM VOCATIONAL FUNDS ARE RESTRICTED TO GRADES 7 - 12.

SYNTHESIS COURSES

These courses are designed to allow students to (1) pull together the knowledge gained in several courses, (2) apply the knowledge in new and novel situations, and (3) develop additional knowledge. These experiences are provided in two major courses: Research and Development and Enterprise.

The Research and Development course first explores the process used to solve problems, then allows individual students or groups of students to solve technological problems.

The Enterprise course emphasizes the industrial enterprise as the societal institution which uses technology to change inputs into desired outputs. Experiences are provided which will develop an in-depth understanding of the management practices used to plan, organize, direct, and control various productive activities.

Flexibility must be maintained in these courses. Students should be allowed to address the content from various approaches. Also, the courses should be open to students with a minimum number of prerequisites.

COURSE TITLE

"Technology Research and Development" (8195) 18 weeks

(Synthesis Level--All Schools) Grade 12

COURSE DESCRIPTION

A study undertaken by an individual or small group to pursue new knowledge or to solve a technological problem.
Experiences would range from research, experimentation, design and development of prototypes or working models.

COURSE OBJECTIVES:

At the completion of this course the student will be able to:

1. Identify and define a technological problem.
2. Solve problems using a research and development process.
3. Seek new knowledge, synthesize this information and be able to formulate it into a report or use it in solving the defined problem.
4. Record and log experimental or design data for use in the documentation of the research and development process.
5. Complete a simplified version of a patent application to insure protection of ideas and control of the disclosure.
6. Develop a schedule of the plan that is going to be used in the pursuit of the research and development process.
7. Evaluate the research and development solutions that have been completed by the individual student.

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Research and Development as a Process - Why used - Where used - When used - How used	View film on innovation, research & development such as from "The American Enterprise," "Fast Forward" or "Connections" series. Discuss the process of identifying, isolating and refining problems. Participate in a brainstorming process as a group.	10%
Research and Development as a Concept - Research * basic * applied - Development (product or service) * imitate * adapt * innovate	Select a technical research and experimentation problem. Isolate the variables in the problem. Design and build the necessary apparatus for the experiment. Conduct the experiment. Gather, analyze, and synthesize the data.	40%
Process to Development (planning how to develop appropriate solutions) - Method - Volume - Quality - Capabilities of tools, equipment, facilities and materials - Sequencing of the process	- Work on a small redesign project assigned by the teacher. * sketch out variable solutions * draw up plans for implementation * work out the redesign as planned - Complete a small group process development design problem (e.g., design a jig to produce a part for a product by considering the questions of method, volume, quality, etc., in the solution.	20%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Product or Service Engineering * Design * Refine * Engineer * Test	As an individual, team or small group select a problem that requires engineering to improve the product and service. Complete the project to the satisfaction of the evaluation team.	30%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Activate the Company - Establish departments	All vice presidents should organize their respective department members and develop roles. - Hand in an organizational chart for each department. Develop the flow of command or communication.	
- Planning	Determine the intent of the company. - Research and development for desired product/goods/service. - Submit preliminary plans to department leaders and president.	15%
- Financial Affairs	Activate departments to: - Prepare bylaws - Prepare budget - Obtain capital - Set up purchasing system - Set up accounting system - Sell stock/seek loan	
- Marketing	Activate departments to develop sales campaign - Prepare department budget - Develop advertising theme - Develop/design packaging - Design advertising formats - Set up sales program	

CONTENT	REPRESENTATIVE ACTIVITES	TIME
Industrial Relations	Activate departments to establish: - Personnel factors - Prepare department budget - Prepare job descriptions - Outline safety program - Determine manpower needs - Check union activities - Determine wage structures	4%
Operating the enterprise - Schedules - Procedures - Processes	Set into operation - Financial accounting - Production design - Quality control - Company newsletters - Bulletin boards - Safety materials - Packaging designs	12%
Production/Goods/Services - Obtaining the company's goods	Set into operation - Tooling needs & construction - Flow charts (processes) - Plant layout - Material layout & handling - Actual production	45%

CONTENT	REPRESENTATIVE ACTIVITES	TIME
	- Safety checks & procedures - Packaging - Reports to stockholders - Inspections	
Delivering the goods/services	Set into operation - Delivery of the product/services - Evaluation of tooling & operations - Sell extra products - Final report to stockholders - Payment of all labor - Handle grievances - Finalize material costs - Payment of material	10%
Reassessment and the close down of the enterprise - Financial - Production/goods - Marketing - Industrial relations	Set into operation - Establishment of service procedures - File articles of dissolution - Submit all final reports to stockholders - Pay dividends - Terminate workers - Remove advertising - Store records - Liquidate company	5%

INITIATING AND IMPLEMENTING NEW AND IMPROVED PROGRAMS

INITIATING AND IMPLEMENTING NEW AND IMPROVED PROGRAMS

The identification, development, implementation, and evaluation of a comprehensive technology education program which reflects the intent of this report will require considerable detailed planning by specific curriculum development teams. The following guidelines are recommended for consideration by those responsible for the development and implementation of the program. It is also recommended that the Standards for Technology Education Programs, which are available from the International Technology Education Association, be used as a basis for steps associated with program identification, development, implementation, and evaluation.

Scope and Sequences

Regardless of school size, the Technology Education program should offer a variety of offerings in each cluster system (communication, construction, manufacturing, and transportation). The courses should be sequential, beginning with orientation and exploration of subject matter, followed by specialized experiences. This program will provide a smooth continuum which would allow a student to move from a beginning foundation phase, which includes basic concepts, knowledge, skills and attitudes necessary for continued learning. Then the student would move through a series of developmental experiences which serve as the transition from basic learning to the pursuit of specialized interests at the concentration or Level IV phase. However, this continuum

should not prevent good students from participating in upper level courses (Level IV) prior to participating in Level II or III courses.

Course Lengths

All proposed courses have been designed for one semester or 18 weeks of instruction. This provides the best opportunity for coverage of the content in each cluster system with a minimal disruption in the over-all scheduling process.

Teacher Load/Class Size

In accord with the national standards, it is recommended that the individual teacher load not exceed 20 students per class or 100 students per teacher for maximum effectiveness in implementing a broad based, comprehensive technology education program that reflects the intent of this document. For purposes of identifying the minimum number of courses which should be offered in a small, middle or large school, a formula of one teacher for every 250 students or 40% of the total student body was used.

Facilities

Ideally, a multi-purpose facility is needed to implement the Level 1 program. A separate facility for each of the four cluster systems should be available for the Levels II, III and IV courses. Recognizing that in most cases this is not realistic, thought was given to implementation of each of these courses using traditional Industrial Arts facilities without extensive modification, expansion of facilities or addition of equipment. However, careful planning and considerable interdisciplinary teamwork among all staff members will be required to insure a balanced comprehensive coverage of all systems at each level. While the existing facilities of a traditional program may be adequate, in all

likelihood some equipment may have to be removed or relocated for maximum efficiency in the implementation of the proposed courses.

Resource Materials

A wide variety of instructional materials will be needed to implement the proposed courses. The recommended activities listed with each course in this document provide clues regarding the type of materials needed to ensure attainment of course objectives. While the total cost for these materials should not exceed the expenditures of a traditional Industrial Arts course, the cost of specific items will probably vary substantially. Individuals responsible for developing specific courses are encouraged to compile a recommended equipment and resource materials list, including selected teaching aides and available computer programs.

Use of Community Resources

One of the major purposes of the technology education program is to prepare students to live in a technological society. It is important, then, that extensive use be made of community resources which are representative of the lay public, business, industry, and government. These special interest groups should be kept fully informed about the technology education program and be given the opportunity to participate in all aspects of the program. The Community should be encouraged to provide experiences for the students which otherwise would not be available in a typical classroom setting. The use of these resources should be incorporated into all locally developed curriculum materials.

Instructional Strategies

A wide variety of instructional strategies should be

identified and utilized in meeting program goals, course objectives, and individual student needs. Much of this proposed curriculum involves student centered instructional activities for both group and individual student learning. These strategies should be directly related to the course objectives and should be designed to meet the unique needs of individual students regardless of ability or career aspirations.

Training

Considerable ongoing training will be needed to adequately prepare new and existing staff to fully implement all aspects of this program. While this training should be a regular part of an ongoing program, any certified Industrial Arts teacher should be familiar with concepts of the recommended courses in this document. There should be little difficulty in developing an appropriate plan for a smooth transition from an existing program to one that is designed to provide broad based, comprehensive developmental experience in all aspects of technology.

Supervision

The implementation and continued refinement of a comprehensive contemporary technology program will require adequate administration and supervision to ensure a well managed program. This administration and supervision should strive toward maximum interdisciplinary planning and teamwork. Capitalize on the unique strengths and talents of all members within the staff. Make extensive use of community resources.

A P P E N D I X A

TAXONOMIES:

Communication

Construction

Manufacturing

Transportation

COMMUNICATION TAXONOMIES

1 Graphic Communications
- 1.1 Printing
  - 1.1.1 Type
    - 1.1.1.1 Relief
    - 1.1.1.2 Screen
    - 1.1.1.3 Lithography
    - 1.1.1.4 Gravure
    - 1.1.1.5 Electrostatic
    - 1.1.1.6 Ink Jet
  - 1.1.2 Process
    - 1.1.2.1 Image Design
    - 1.1.2.2 Image Assembly
    - 1.1.2.3 Image Conversion
    - 1.1.2.4 Image Carrier Preparation
    - 1.1.2.5 Image Transfer
    - 1.1.2.6 Finishing
  - 1.1.3 Products
    - 1.1.3.1 Material
      - 1.1.3.1.1 Paper
      - 1.1.3.1.2 Non-Paper
    - 1.1.3.2 Use
      - 1.1.3.2.1 Consumable
      - 1.1.3.2.2 Permanent
  - 1.1.4 Impact (Domestic/Global)
    - 1.1.4.1 Economic
    - 1.1.4.2 Political
    - 1.1.4.3 Values/Attitudes
    - 1.1.4.4 Environment
- 1.2 Photography
  - 1.2.1 Type
    - 1.2.1.1 Film Imaging
      - 1.2.1.1.1 Silver Base
      - 1.2.1.1.2 Non-Silver Base
    - 1.2.1.2 Electronic Imaging
  - 1.2.2 Process
    - 1.2.2.1 Image Design
    - 1.2.2.2 Image Assembly
    - 1.2.2.3 Image Exposure
    - 1.2.2.4 Image Conversion
    - 1.2.2.5 Image Reproduction
  - 1.2.3 Products
    - 1.2.3.1 Film
    - 1.2.3.2 Print
    - 1.2.3.3 Video (?)
  - 1.2.4 Impact (Domestic/Global)
    - 1.2.4.1 Economic
    - 1.2.4.2 Political
    - 1.2.4.3 Values/Attitudes

1.2.4.4 Environment
1.2.4.5 Aesthetic

2 Electronic Communications
2.1 Telecommunications
2.1.1 Types
2.1.1.1 One-way Communications
2.1.1.1.1 Radio
2.1.1.1.2 Television
2.1.1.2 Two-way Communications
2.1.1.2.1 Radio
2.1.1.2.2 Radar
2.1.2 Process
2.1.2.1 Designing
2.1.2.2 Encoding
2.1.2.3 Transmitting
2.1.2.4 Storing/Retrieving
2.1.2.5 Receiving
2.1.2.6 Decoding
2.1.3 Product
2.1.3.1 Entertainment
2.1.3.2 Information/Data
2.1.3.3 Detection
2.1.4 Impact (Domestic/Global)
2.1.4.1 Economic
2.1.4.2 Political
2.1.4.3 Values/Attitudes
2.1.4.4 Environment
2.2 Conductor
2.2.1 Types
2.2.1.1 One way
2.2.1.1.1 Voice
(Public Address System)
2.2.1.1.2 Data
2.2.1.2 Two way
2.2.1.2.1 Voice
(Telephone)
2.2.1.2.2 Data
2.2.1.2.2.1 Telegraph
2.2.1.2.2.2 Telephone
2.2.2 Process
2.2.2.1 Designing
2.2.2.2 Encoding
2.2.2.3 Transmitting
2.2.2.4 Storing/Retrieving
2.2.2.5 Receiving
2.2.2.6 Decoding
2.2.3 Product
2.2.3.1 Entertainment
2.2.3.2 Information/Data
2.2.3.3 Detection

2.2.4 Impacts (Domestic/Global)
2.2.4.1 Economic
2.2.4.2 Political
2.2.4.3 Values/Attitudes
2.2.4.4 Environment
2.3 Computer Systems
2.3.1 Types
2.3.1.1 Analog
2.3.1.2 Digital
2.3.2 Process
2.3.2.1 Input
2.3.2.2 Storage
2.3.2.3 Processing
2.3.2.4 Output
2.3.3 Interface
2.3.3.1 Human
2.3.3.2 Machine/Equipment
2.3.4 Products
2.3.4.1 Entertainment
2.3.4.2 Computations
2.3.4.3 Detection/Control
2.3.4.4 Data Exchange
2.3.5 Impacts
2.3.5.1 Economic
2.3.5.2 Political
2.3.5.3 Values/Attitudes
2.3.5.4 Environment

3 Light Communication
3.1 Interactive
3.1.1 Light Sources
3.1.1.1 Coherent
3.1.1.2 Non-coherent
3.1.2 Process
3.1.2.1 Designing
3.1.2.2 Encoding
3.1.2.3 Transmitting
3.1.2.4 Receiving
3.1.2.5 Decoding
3.1.3 Products
3.1.3.1 Entertainment
3.1.3.2 Information/Data
3.1.3.3 Detection
3.1.4 Impacts
3.1.4.1 Economic
3.1.4.2 Political
3.1.4.3 Values/Attitudes
3.1.4.4 Environment

- 3.2 Passive
  - 3.2.1 Light Sources
    - 3.2.1.1 Coherent
    - 3.2.1.2 Non-coherent
  - 3.2.2 Process
    - 3.2.2.1 Designing
    - 3.2.2.2 Encoding
    - 3.2.2.3 Transmitting
    - 3.2.2.4 Receiving
    - 3.2.2.5 Decoding
  - 3.2.3 Products
    - 3.2.3.1 Entertainment
    - 3.2.3.2 Information/Data
    - 3.2.3.3 Detection
  - 3.2.4 Impacts
    - 3.2.4.1 Economic
    - 3.2.4.2 Political
    - 3.2.4.3 Values/Attitudes
    - 3.2.4.4 Environment

- 4 Acoustic Communication
  - 4.1 Sonic Detection
    - 4.1.1 Transmission Media
      - 4.1.1.1 Gas
      - 4.1.1.2 Liquid
      - 4.1.1.3 Solid
    - 4.1.2 Process
      - 4.1.2.1 Modulation
      - 4.1.2.2 Transmitting
      - 4.1.2.3 Receiving
      - 4.1.2.4 Decoding
    - 4.1.3 Products
      - 4.1.3.1 Information/Data
      - 4.1.3.2 Detection/Control
    - 4.1.4 Impacts
      - 4.1.4.1 Economic
      - 4.1.4.2 Political
      - 4.1.4.3 Values/Attitudes
      - 4.1.4.4 Environment
  - 4.2 Storage/Retrieval
    - 4.2.1 Types
      - 4.2.1.1 Magnetic
      - 4.2.1.2 Mechanical
    - 4.2.2 Process
      - 4.2.2.1 Encoding
      - 4.2.2.2 Storing
      - 4.2.2.3 Retrieving
      - 4.2.2.4 Decoding
    - 4.2.3 Products
      - 4.2.3.1 Information/Data
      - 4.2.3.2 Entertainment

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4.2.4 Impacts
- 4.2.4.1 Economic
- 4.2.4.2 Political
- 4.2.4.3 Values/Attitudes
- 4.2.4.4 Environment

CONSTRUCTION TAXONOMIES

1. Construction Managed Activities
    1.1 Research and Development
        1.1.1 Initiating the Project
            1.1.1.1 Formulating
                1.1.1.1.1 Determining Objectives
                    1.1.1.1.1.1 Stating Goals
                    1.1.1.1.1.2 Consulting
                    1.1.1.1.1.3 Establishing Project Criteria
                    1.1.1.1.1.4 Evaluating
                    1.1.1.1.1.5 Describing Objectives
                1.1.1.1.2 Researching
                    1.1.1.1.2.1 Locating Data
                    1.1.1.1.2.2 Retrieving Data
                    1.1.1.1.2.3 Describing Data
                        1.1.1.1.2.3.1 Drawing
                        1.1.1.1.2.3.2 Reporting
                        1.1.1.1.2.3.3 Classifying-Categorizing
                        1.1.1.1.2.3.4 Defining
                    1.1.1.1.2.4 Evaluating Data
                        1.1.1.1.2.4.1 Comparing
                        1.1.1.1.2.4.2 Contrasting
                        1.1.1.1.2.4.3 Measuring Against Criteria
                        1.1.1.1.2.4.4 Rating
                    1.1.1.1.2.5 Forecasting
            1.1.1.2 Administering the Project
                1.1.1.2.1 Directing
                    1.1.1.2.1.1 Coordinating
                    1.1.1.2.1.2 Assigning
                    1.1.1.2.1.3 Supervising
                    1.1.1.2.1.4 Inspecting
                1.1.1.2.2 Authorizing
                    1.1.1.2.2.1 Verifying
                    1.1.1.2.2.2 Certifying
                    1.1.1.2.2.3 Approving
                    1.1.1.2.2.4 Redefining
            1.1.1.3 Project Programming
                1.1.1.3.1 Evaluating
                    1.1.1.3.1.1 Analyzing Data
                    1.1.1.3.1.2 Comparing
                    1.1.1.3.1.3 Contrasting
                1.1.1.3.2 Selecting
                    1.1.1.3.2.1 Examining
                    1.1.1.3.2.2 Eliminating
                    1.1.1.3.2.3 Adapting
                    1.1.1.3.2.4 Adopting
                1.1.1.3.2 Presenting
                    1.1.1.3.2.1 Scheduling
                    1.1.1.3.3.2 Diagramming

1.1.1.3.3.3 Reporting
1.1.1.3.3.4 Demonstrating
1.1.1.3.3.5 Summarizing
1.1.2 Developing the Project
1.1.2.1 Designing
1.1.2.1.1 Evaluating Concepts
1.1.2.1.1.1 Evaluating the Program
1.1.2.1.1.2 Determining Functional Relationships
1.1.2.1.2 Postulating Solutions
1.1.2.1.2.1 Scaling Functional Relationships
1.1.2.1.2.2 Presenting Solutions
1.1.2.1.3 Selecting a Solution
1.1.2.1.3.1 Analyzing Alternative Solutions
1.1.2.1.3.2 Appraising Alternative Solutions
1.1.2.1.3.3 Evaluating Alternative Solutions
1.1.2.2 Engineering
1.1.2.2.1 Interpreting Drawings and Reports
1.1.2.2.2 Establishing Detail Design Criteria and Standards
1.1.2.2.3 Analyzing Problems-Proposal
1.1.2.2.3.1 Grouping
1.1.2.2.3.2 Classifying
1.1.2.2.3.3 Identifying
1.1.2.2.4 Estimating Sizes-Capacities
1.1.2.2.4.1 Referring (past experience)
1.1.2.2.4.2 Comparing
1.1.2.2.4.3 Approximating
1.1.2.2.5 Detail Designing
1.1.2.2.5.1 Standardizing Component/Elements
1.1.2.2.5.2 Computing
1.1.2.2.5.2.1 Calculating
1.1.2.2.5.2.2 Calibrating
1.1.2.2.5.2.3 Appraising
1.1.2.2.5.3 Experimenting
1.1.2.2.5.3.1 Modeling
1.1.2.2.5.3.2 Building Prototypes
1.1.2.2.5.3.3 Testing
1.1.2.2.5.4 Preparing Working Drawings
1.1.2.2.5.4.1 Scaling
1.1.2.2.5.4.2 Dimensioning
1.1.2.2.5.4.3 Notating
1.1.2.2.5.4.4 Referencing and Titling
1.1.2.2.5.5 Securing Approval
1.1.2.2.5.5.1 Inspecting
1.1.2.2.5.5.2 Authorizing
1.1.2.2.6 Specifying
1.1.2.2.6.1 Preparing Outline Specifications
1.1.2.2.6.2 Drafting Final Specifications
1.1.3 Implementing
1.1.3.1 Contracting

1.1.3.2 Construction Programming
1.1.3.3 Procuring
1.1.3.4 Supervising Construction

1.2 Marketing
1.2.1 Analyzing the Market
1.2.1.1 Studying National and Local Levels of Economic Activity
1.2.1.2 Detecting Employment and Income Trends
1.2.1.3 Ascertaining Population Patterns and Trends
1.2.1.4 Studying the Cost and Availability of Mortgage Funds
1.2.1.5 Synthesizing the Demand for Particular Types of Construction Projects
1.2.1.6 Detecting Client Needs, Wants and Spending Patterns
1.2.1.7 Reviewing Government Regulations and Legal Restrictions
1.2.2 Establishing Marketing Strategy
1.2.2.1 Selecting Products
1.2.2.2 Selecting Target Clients
1.2.2.3 Pricing Project(s)
1.2.2.4 Timing Entry Into Market
1.2.3 Promoting
1.2.3.1 Advertising
1.2.3.2 Showing Property
1.2.3.3 Qualifying Potential Buyers
1.2.3.4 Pursuing Potential Buyers
1.2.4 Closing the Sale
1.2.4.1 Drawing Up a Sales Agreement
1.2.4.2 Complying with Terms of Sales Agreement
1.2.4.3 Transferring Ownership

1.3 Industrial Relations
1.3.1 Hiring
1.3.1.1 Recruiting
1.3.1.2 Selecting
1.3.1.3 Inducting
1.3.2 Training
1.3.2.1 On-the-job Training
1.3.2.2 Other Training
1.3.3 Providing Benefits
1.3.3.1 Paying Wages and Salaries
1.3.3.2 Paying Fringe Benefits
1.3.3.3 Providing Physical Environment
1.3.3.4 Providing Social Environment
1.3.4 Providing Career Options
1.3.4.1 Promoting
1.3.4.2 Demoting
1.3.4.3 Transferring
1.3.4.4 Discharging
1.3.4.5 Retiring

1.4 Financing
- 1.4.1 Appraising Property
  - 1.4.1.1 Inspecting
  - 1.4.1.2 Recording
  - 1.4.1.3 Describing
  - 1.4.1.4 Analyzing
  - 1.4.1.5 Correlating
  - 1.4.1.6 Estimating
  - 1.4.1.7 Reporting
  - 1.4.1.8 Certifying
- 1.4.2 Estimating Probable Costs (land & construction)
  - 1.4.2.1 Measuring
  - 1.4.2.2 Pricing
  - 1.4.2.3 Calculating
  - 1.4.2.4 Projecting
  - 1.4.2.5 Accounting
  - 1.4.2.6 Comparing
  - 1.4.2.7 Evaluating
- 1.4.3 Funding
  - 1.4.3.1 Backing
  - 1.4.3.2 Capitalizing
  - 1.4.3.3 Mortgaging
  - 1.4.3.4 Borrowing
  - 1.4.3.5 Selling
  - 1.4.3.6 Purchasing
  - 1.4.3.7 Amortizing
  - 1.4.3.8 Incorporating
  - 1.4.3.9 Matching
- 1.4.4 Documenting
  - 1.4.4.1 Describing
  - 1.4.4.2 Contracting
  - 1.4.4.3 Floating
  - 1.4.4.4 Legalizing
- 1.4.5 Budgeting
  - 1.4.5.1 Allocating
  - 1.4.5.2 Timing
- 1.4.6 Making Payments

2 Construction Production Processes

2.1 Preparing the Site
- 2.1.1 Clearing the Site
  - 2.1.1.1 Providing Temporary Access and Protection
    - 2.1.1.1.1 Protecting Personnel and Property
      - 2.1.1.1.1.1 Posting
      - 2.1.1.1.1.2 Fencing
      - 2.1.1.1.1.3 Banking
      - 2.1.1.1.1.4 Ditching
      - 2.1.1.1.1.5 Bracing and Shoring
      - 2.1.1.1.1.6 Weatherproofing

2.1.1.1.2 Laying Roads and Walkways
2.1.1.1.2.1 Grading
2.1.1.1.2.2 Bridging
2.1.1.1.2.3 Compacting
2.1.1.1.2.4 Surfacing
2.1.1.1.2.5 Rolling
2.1.1.2 Reducing Obstacles
2.1.1.2.1 Demolishing and Salvaging
2.1.1.2.1.1 Disassembling
2.1.1.2.1.2 Wrecking
2.1.1.2.1.3 Bulldozing
2.1.1.2.1.4 Cutting
2.1.1.2.1.5 Chaining
2.1.1.2.1.6 Blasting
2.1.1.2.1.7 Burning
2.1.1.2.2 Extracting
2.1.1.2.2.1 Draining
2.1.1.2.2.2 Rerouting
2.1.1.2.2.3 Digging
2.1.1.2.2.4 Ripping
2.1.1.2.2.5 Scraping
2.1.1.2.2.6 Grubbing
2.1.1.3 Handling Materials
2.1.1.3.1 Transferring Materials
2.1.1.3.1.1 Loading and Hauling
2.1.1.3.1.2 Dragging
2.1.1.3.1.3 Pushing
2.1.1.3.1.4 Pumping
2.1.1.3.2 Disposing of Materials on-site
2.1.1.3.2.1 Stockpiling-Stacking
2.1.1.3.2.2 Burying
2.1.1.3.2.3 Burning
2.1.1.3.2.4 Spreading
2.1.2 Setting up Temporary Facilities
2.1.2.1 Establishing Temporary Shelters
2.1.2.1.1 Transporting Temporary Shelters
2.1.2.1.1.1 Hauling
2.1.2.1.1.2 Towing
2.1.2.1.2 Setting-up Temporary Shelters
2.1.2.1.2.1 Parking
2.1.2.1.2.2 Fabricating
2.1.2.2 Providing Temporary Utilities
2.1.2.2.1 Providing Water
2.1.2.2.1.1 Connecting
2.1.2.2.1.2 Plumbing
2.1.2.2.1.3 Welling
2.1.2.2.1.4 Storing
2.1.2.2.2 Providing Power
2.1.2.2.2.1 Connecting
2.1.2.2.2.2 Wiring
2.1.2.2.2.3 Generating

2.1.3 Surveying for Constructing
- 2.1.3.1 Referencing to Existing Features
  - 2.1.3.1.1 Measuring
    - 2.1.3.1.1.1 Reading
    - 2.1.3.1.1.2 Recording
  - 2.1.3.1.2 Marking
- 2.1.3.2 Laying Out the Structure
  - 2.1.3.2.1 Establishing Control Points
    - 2.1.3.2.1.1 Measuring
    - 2.1.3.2.1.2 Marking
  - 2.1.3.2.2 Establishing Offset Lines
    - 2.1.3.2.2.1 Measuring
    - 2.1.3.2.2.2 Marking
    - 2.1.3.2.2.3 Leveling
    - 2.1.3.2.2.4 Protecting

2.1.4 Earthworking
- 2.1.4.1 Mobilizing Equipment
  - 2.1.4.1.1 Transporting
    - 2.1.4.1.1.1 Driving
    - 2.1.4.1.1.2 Hauling and Towing
  - 2.1.4.1.2 Setting-up
    - 2.1.4.1.2.1 Unloading
    - 2.1.4.1.2.2 Positioning
    - 2.1.4.1.2.3 Assembling
    - 2.1.4.1.2.4 Servicing
- 2.1.4.2 Earthmoving
  - 2.1.4.2.1 Loosening
    - 2.1.4.2.1.1 Blasting
    - 2.1.4.2.1.2 Breaking and Spalling
    - 2.1.4.2.1.3 Scarifying and Ripping
  - 2.1.4.2.2 Extracting
    - 2.1.4.2.2.1 Digging
    - 2.1.4.2.2.2 Scraping
    - 2.1.4.2.2.3 De-Watering
  - 2.1.3.2.3 Transferring
    - 2.1.4.2.3.1 Loading and Hauling
    - 2.1.4.2.3.2 Pushing
    - 2.1.4.2.3.3 Pumping
    - 2.1.4.2.3.4 Conveying
  - 2.1.4.2.4 Disposing
    - 2.1.4.2.4.1 Stockpiling-Stacking
    - 2.1.4.2.4.2 Depositing
    - 2.1.4.2.4.3 Spreading
- 2.1.4.3 Protecting Existing Utilities and Structures
  - 2.1.4.3.1 Rerouting
  - 2.1.4.3.2 Bracing and Shoring
  - 2.1.4.3.3 Underpininning
    - 2.1.4.3.3.1 Digging
    - 2.1.4.3.3.2 Supporting
- 2.1.4.4 Shaping and Stabilizing Earthworks
  - 2.1.4.4.1 Cleaning or Washing
  - 2.1.4.4.2 Grading

2.1.4.4.2.1 Compacting
2.1.4.4.2.2 Grouting
2.1.4.4.2.3 Scaling
2.1.4.4.2.4 Filling
2.1.4.4.3 Slipping
2.1.4.4.4 Sheathing
2.1.4.4.5 Bracing and Shoring
2.1.4.4.6 Treating
2.1.4.4.7 Piling
2.1.4.4.8 Cofferdamming

2.2 Building the Structure

2.2.1 Setting Foundations
2.2.1.1 Making and Placing Forms
2.2.1.1.1 Building Forms
2.2.1.1.1.1 Laying Out
2.2.1.1.1.2 Cutting
2.2.1.1.1.3 Preassembling Components
2.2.1.1.2 Assembling in Place
2.2.1.1.2.1 Transferring
2.2.1.1.2.2 Positioning
2.2.1.1.2.3 Fastening
2.2.1.1.2.4 Stabilizing and Adjusting
2.2.1.1.3 Treating Forms
2.2.1.1.3.1 Cleaning
2.2.1.1.3.2 Coating
2.2.1.1.3.3 Soaking
2.2.1.2 Setting Reinforcement
2.2.1.2.1 Cleaning and Shaping
2.2.1.2.2 Transferring and Placing
2.2.1.2.3 Supporting
2.2.1.2.3.1 Seating
2.2.1.2.3.2 Tying
2.2.1.3 Preparing Foundation Materials
2.2.1.3.1 Treating
2.2.1.3.1.1 Washing
2.2.1.3.1.2 Chilling
2.2.1.3.2 Proportioning and Batching
2.2.1.3.2.1 Screening
2.2.1.3.2.2 Measuring
2.2.1.3.3 Mixing
2.2.1.4 Handling Materials
2.2.1.4.1 Transferring
2.2.1.4.1.1 Hauling
2.2.1.4.1.2 Conveying
2.2.1.4.1.3 Pumping
2.2.1.4.2 Placing
2.2.1.4.2.1 Dumping
2.2.1.4.2.2 Chuting
2.2.1.4.3 Consolidating
2.2.1.4.3.1 Vibrating
2.2.1.4.3.2 Tamping and Spading

2.2.1.4.4 Building in Inserts, Anchors, Ties Hangers
2.2.1.4.5 Finishing
2.2.1.4.5.1 Striking Off
2.2.1.4.5.2 Edging
2.2.1.4.5.3 Floating
2.2.1.5 Bonding
2.2.1.5.1 Preparing Surfaces
2.2.1.5.1.1 Scraping
2.2.1.5.1.2 Washing
2.2.1.5.1.3 Grouting
2.2.1.5.2 Jointing
2.2.1.5.2.1 Placing
2.2.1.5.2.2 Tamping
2.2.1.6 Curing
2.2.1.6.1 Controlling Moisture
2.2.1.6.1.1 Ponding and Flooding
2.2.1.6.1.2 Mist Spraying
2.2.1.6.1.3 Covering
2.2.1.6.1.4 Chemical Treating
2.2.1.6.2 Controlling Temperature
2.2.1.6.2.1 Chilling
2.2.1.6.2.2 Covering
2.2.1.7 Removing Forms
2.2.1.7.1 Stripping Forms
2.2.1.7.1.1 Unfastening
2.2.1.7.1.2 Tapping
2.2.1.7.1.3 Pulling
2.2.1.7.1.4 Lifting and Stacking
2.2.1.7.2 Cleaning Forms
2.2.1.7.2.1 Chipping and Scraping
2.2.1.7.2.2 Washing
2.2.1.7.2.3 Stockpiling
2.2.1.8 Finishing Foundations
2.2.1.8.1 Cleaning
2.2.1.8.1.1 Patching
2.2.1.8.1.2 Chipping and Chiseling
2.2.1.8.1.3 Treating
2.2.1.8.2 Backfilling
2.2.1.8.2.1 Bulldozing
2.2.1.8.2.2 Compacting
2.2.2 Building the Major Structural Elements
2.2.2.1 Preparing Materials
2.2.2.1.1 Laying out
2.2.2.1.2 Cutting
2.2.2.1.3 Forming
2.2.2.1.4 Proportioning and Mixing
2.2.2.1.5 Treating
2.2.2.2 Fabricating Components and Temporary Forms

2.2.2.2.1 Preparing Materials
2.2.2.2.2 Sub-Assembling
2.2.2.3 Setting Reinforcement
2.2.2.4 Handling Materials and Components
2.2.2.4.1 Transferring
2.2.2.4.1.1 Hoisting
2.2.2.4.1.2 Carrying
2.2.2.4.2 Positioning
2.2.2.4.2.1 Locating
2.2.2.4.2.2 Bracing and Holding
2.2.2.4.2.3 Aligning
2.2.2.4.2.4 Placing
2.2.2.4.3 Assembling
2.2.2.4.3.1 Fastening
2.2.2.4.3.1.1 Pinning
2.2.2.4.3.1.2 Welding
2.2.2.4.3.2 Bonding
2.2.2.4.3.2.1 Joining
2.2.2.4.3.2.2 Adhering
2.2.2.5 Treating
2.2.2.5.1 Curing
2.2.2.5.2 Tensioning
2.2.2.5.3 Pressurizing
2.2.2.5.4 Coating
2.2.2.5.5 Fireproofing
2.2.2.6 Removing Temporary Forms
2.2.2.6.1 Stripping
2.2.2.6.2 Cleaning
2.2.2.6.3 Stockpiling
2.2.2.7 Finishing
2.2.2.7.1 Abrading
2.2.2.7.2 Patching
2.2.2.7.3 Coating

2.3 Installing Utility Systems (e.g., Electrical, Plumbing, communication, HVAC, Transportation)
2.3.1 Installing Permanent Utilities and Mechanical Plant
2.3.1.1 Preparing Materials and Components
2.3.1.1.1 Laying out
2.3.1.1.2 Cutting
2.3.1.1.3 Forming
2.3.1.1.4 Treating
2.3.1.1.5 Fabricating Components
2.3.1.2 Handling Materials
2.3.1.2.1 Transferring
2.3.1.2.2 Positioning
2.3.1.3 Fastening in Place
2.3.1.3.1 Pinning
2.3.1.3.2 Welding
2.3.1.3.3 Hooking
2.3.1.3.4 Clamping
2.3.1.3.5 Embedding and Seating

2.3.1.4 Connecting and Jointing
2.3.1.4.1 Bonding
2.3.1.4.2 Pinning
2.3.1.4.3 Welding
2.3.1.4.4 Soldering
2.3.1.4.5 Splicing
2.3.1.4.6 Clamping
2.3.1.4.7 Socketing
2.3.1.4.8 Sealing
2.3.1.4.9 Treating
2.3.2 Providing Temporary Equipment
2.3.2.1 Handling Equipment
2.3.2.1.1 Transferring
2.3.2.1.2 Positioning
2.3.2.1.3 Assembling
2.3.2.2 Securing in Place
2.3.2.2.1 Pinning
2.3.2.2.2 Welding
2.3.2.2.3 Clamping
2.3.2.2.4 Tying
2.3.2.2.5 Bracing
2.3.2.2.6 Hooking
2.3.2.3 Removing Temporary Equipment
2.3.2.3.1 Disassembling
2.3.2.3.2 Handling Equipment
2.3.2.3.2.1 Loading
2.3.2.3.2.2 Hauling
2.3.2.3.2.3 Stockpiling
2.4 Enclosing the Structure (rough finishing)
2.4.1 Preparing Materials
2.4.1.1 Laying Out
2.4.1.2 Cutting
2.4.1.3 Forming
2.4.1.4 Mixing
2.4.1.5 Making Temporary Formwork
2.4.1.6 Fabricating Components
2.4.1.7 Treating
2.4.2 Handling Materials and Components
2.4.2.1 Transferring Materials and Components
2.4.2.2 Positioning Materials and Components
2.4.3 Assembling in Place
2.4.3.1 Pinning
2.4.3.2 Welding
2.4.3.3 Bonding
2.4.3.4 Coupling
2.5 Finishing the Structure (fine finishing)
2.5.1 Preparing Subsurfaces
2.5.1.1 Abrading
2.5.1.2 Grounding
2.5.2 Preparing Materials

2.5.2.1 Laying Out
2.5.2.2 Cutting
2.5.2.3 Forming
2.5.2.4 Mixing
2.5.2.5 Making Temporary Formwork
2.5.2.6 Assembling Prefabricated Components
2.5.2.7 Treating
2.5.3 Handling Materials
2.5.3.1 Transferring Materials
2.5.3.2 Positioning
2.5.4 Trimming
2.5.4.1 Fastening and Connecting
2.5.4.1.1 Pinning
2.5.4.1.2 Welding
2.5.4.1.3 Bonding
2.5.4.1.4 Coupling
2.5.4.2 Coating and Applying
2.5.4.2.1 Brushing
2.5.4.2.2 Spraying
2.5.4.2.3 Rolling
2.5.4.2.4 Troweling
2.5.4.2.5 Sealing
2.5.5 Removing Equipment and Debris
2.5.5.1 Demobilizing Equipment
2.5.5.1.1 Disassembling
2.5.5.1.2 Transferring
2.5.5.2 Cleaning up
2.5.5.2.1 Scraping
2.5.5.2.2 Picking Up
2.5.5.2.3 Sweeping
2.5.5.2.4 Washing
2.5.5.2.5 Polishing
2.6 Completing the Site
2.6.1 Removing Temporary Plant and Facilities
2.6.1.1 Removing Temporary Water and Power Facilities
2.6.1.1.1 Disassembling, Disconnecting
2.6.1.1.2 Handling Components
2.6.1.2 Removing Contractor's Equipment
2.6.1.2.1 Disassembling
2.6.1.2.2 Handling Equipment
2.6.1.2.2.1 Loading
2.6.1.2.2.2 Hauling
2.6.2 Landscaping
2.6.2.1 Building Accesses
2.6.2.1.1 Surveying for Accesses
2.6.2.1.2 Earthmoving
2.6.2.1.3 Setting the Base
2.6.2.1.4 Installing Circulatory Systems
2.6.2.1.5 Finishing the Access

2.6.2.1.5.1 Surfacing
2.6.2.1.5.2 Trimming
2.6.3 Building Features
2.6.3.1 Surveying for Constructing
2.6.3.2 Earthmoving
2.6.3.3 Building the Feature
2.6.3.4 Installing Circulatory Systems
2.6.3.5 Finishing the Feature
2.6.4 Shaping the Finishing Earth
2.6.4.1 Laying out
2.6.4.2 Earthmoving
2.6.4.2.1 Banking
2.6.4.2.2 Filling
2.6.4.3 Preparing the Surface
2.6.4.3.1 Grading
2.6.4.3.2 Turning
2.6.4.3.3 Spreading
2.6.4.3.4 Treating
2.6.4.4 Planting and Surfacing
2.6.4.4.1 Seeding
2.6.4.4.2 Sodding
2.6.4.4.3 Digging and Placing
2.6.4.4.4 Spreading
2.6.4.4.5 Treating
2.6.4.4.6 Protecting
2.6.5 Removing Landscaping Equipment and Debris
2.6.5.1 Demobilizing Equipment
2.6.5.1.1 Loading and Hauling
2.6.5.1.2 Towing
2.6.5.1.3 Driving
2.6.5.2 Cleaning Up
2.6.5.2.1 Picking Up
2.6.5.2.2 Raking
2.6.5.2.3 Sweeping
2.6.5.2.4 Burying
2.6.5.2.5 Burning
2.6.5.2.6 Dumping
2.7 Servicing the Project
2.7.1 Diagnosing/Troubleshooting
2.7.2 Repairing
2.7.3 Altering
2.7.4 Installing
2.7.5 Maintaining

3 Construction Managerial Processes
3.1 Planning
3.1.1 Formulating
3.1.1.1 Determining Goals
3.1.1.2 Establishing Specific Objectives
3.1.1.3 Setting Policies

3.1.1.4 Forecasting
3.1.1.5 Programming
3.1.2 Researching
3.1.2.1 Retrieving
3.1.2.2 Describing
3.1.2.3 Experimenting
3.1.3 Designing
3.1.3.1 Determining Function
3.1.3.2 Preparing Performance Specification
3.1.3.3 Postulating a Solution-in-Principle
3.1.3.4 Making Simple Models
3.1.3.5 Postulating Alternate Solutions
3.1.3.6 Making Working or Scale Models
3.1.3.7 Selecting Solution
3.1.3.8 Communicating Design Solution
3.1.3.9 Making Prototype
3.1.4 Engineering
3.1.4.1 Detailing Design Communication
3.1.4.2 Detailing Specifications and Standards
3.1.4.3 Work Design (methods, standards, processes)
3.1.4.4 Estimating
3.1.4.5 Scheduling
3.2 Organizing
3.2.1 Structuring
3.2.1.1 Analyzing Work Tasks
3.2.1.2 Determining Worker Functions
3.2.1.3 Establishing Roles
3.2.1.4 Setting Work Conditions
3.2.2 Supplying
3.2.2.1 Requisitioning
3.2.2.2 Procuring
(Subcontracting)
3.2.2.2.1.1 Advertising for Bid(s)
3.3.3.1.1.1 Inviting (Bid(s)
3.3.3.1.1.2 Selecting Bidder(s)
3.3.3.1.1.3 Instructing Bidder(s)
3.2.2.2.1.2 Preparing Bid(s)
3.3.3.1.2.1 Inspecting Site
3.3.3.1.2.2 Quantifying Labor and Materials
3.3.3.1.2.3 Estimating
3.2.2.2.1.3 Accepting a Bid
3.3.3.1.3.1 Opening Bids
3.3.3.1.3.2 Selecting a Bid
3.2.2.3 Employing
3.2.2.3.1 Specifying Work Roles
3.2.2.3.2 Notifying Prospective Employees
3.2.2.3.3 Selecting Personnel
3.2.2.4 Purchasing

3.2.2.4.1 Writing Detailed Specifications
3.2.2.4.2 Ordering
3.2.2.4.3 Checking
3.2.2.4.4 Claiming
3.2.2.5 Leasing
3.2.2.5.1 Writing Detailed Specifications
3.2.2.5.2 Ordering
3.2.2.5.3 Checking
3.2.2.5.4 Claiming
3.2.2.5.5 Returning
3.2.2.6 Obtaining Licenses, Permits and Authorizations
3.2.2.6.1 Applying
3.2.2.6.2 Securing
3.2.3 Scheduling
3.2.3.1 Grouping
3.2.3.2 Allocating Time
3.2.4 Routing
3.2.4.1 Establishing Departure and Arrival Time
3.2.4.2 Establishing Path to be Followed
3.2.5 Storing
3.3 Directing
3.3.1 Coordinating
3.3.2 Assigning
3.3.3 Supervising
3.3.4 Inspecting
3.3.5 Authorizing
3.4 Controlling
3.4.1 Monitoring
3.4.1.1 Inspecting
3.4.1.2 Inventorying
3.4.1.3 Timekeeping
3.4.2 Reporting
3.4.2.1 Compiling
3.4.2.2 Appraising
3.4.2.3 Notifying
3.4.3 Correcting
3.4.3.1 Adjusting
3.4.3.2 Expediting
3.4.3.3 Restraining
3.4.3.4 Replanning
3.4.3.5 Redirecting
3.4.3.6 Retraining

MANUFACTURING TAXONOMIES

MANUFACTURING TAXONOMIES

1 Manufacturing Inputs
- 1.1 Material
  - 1.1.1 Direct
  - 1.1.2 Indirect
- 1.2 Human
  - 1.2.1 Managerial
  - 1.2.2 Scientific/Technical
  - 1.2.3 Office/Clerical
  - 1.2.4 Worker/Operative
- 1.3 Capital
  - 1.3.1 Plant
  - 1.3.2 Equipment
- 1.4 Finance
  - 1.4.1 Debt
  - 1.4.2 Equity
- 1.5 Knowledge
  - 1.5.1 Technological
  - 1.5.2 Scientific
  - 1.5.3 Humanities
  - 1.5.4 Formal
- 1.6 Energy

2 Transformation Processes
- 2.1 Extracting
  - 2.1.1 Drilling
    - 2.1.1.1 Methods
      - 2.1.1.1.1 Cable tool
      - 2.1.1.1.2 Rotary
    - 2.1.1.2 Extracting materials
      - 2.1.1.2.1 Energy drive
      - 2.1.1.2.2 Pumping
  - 2.1.2 Harvesting (Cutting)
    - 2.1.2.1.1 Selective
    - 2.1.2.1.2 Clear Cutting
  - 2.1.3 Mining
    - 2.1.3.1 Surface mining
      - 2.1.3.1.1 Placer
        - 2.1.3.1.1.1 Panning
      - 2.1.3.1.2 Dredging
        - 2.1.3.1.2.1 Floating
        - 2.1.3.1.2.2 Drag line
      - 2.1.3.1.3 Open pit
      - 2.1.3.1.4 Strip
      - 2.1.3.1.5 Quarry
    - 2.1.3.2 Underground
      - 2.1.3.2.1 Level and shaft
      - 2.1.3.2.2 Room and pillar
    - 2.1.3.3 Underwater
      - 2.1.3.3.1 Precipitating
      - 2.1.3.3.2 Leaching

2.1.3.3.3 Frasch
2.1.3.3.4 Drag line
2.1.4 Other
2.1.4.1 Evaporation
2.1.4.2 Electrolysis
2.2 Primary Processing
2.2.1 Thermal Processing
2.2.1.1 Smelting
2.2.1.2 Distilling
2.2.1.3 Evaporating
2.2.2 Chemical processing
2.2.2.1 Oxidizing
2.2.2.2 Reducing
2.2.3 Mechanical Processing
2.2.3.1 Cutting
2.2.3.2 Slicing and shearing
2.2.3.3 Crushing and milling
2.2.3.4 Screening
2.2.3.5 Floating and sedimenting
2.2.3.6 Filtering
2.2.4 Electrical processing
2.2.4.1 Magnetic separating
2.2.4.2 Electostatic separating
2.3 Secondary Processing
2.3.1 Casting and molding
2.3.1.1 Preparing the mold
2.3.1.1.1 Expendable
2.3.1.1.2 Permanent
2.3.1.2 Preparing the material
2.3.1.2.1 Melting
2.3.1.2.2 Dissolving/suspending
2.3.1.2.3 Compounding liquids
2.3.1.3 Introducing materials into molds
2.3.1.3.1 Pouring
2.3.1.3.2 Pressurizing
2.3.1.4 Solidifying the material
2.3.1.4.1 Cooling
2.3.1.4.2 Drying
2.3.1.4.3 Chemical condition (reaction)
2.3.1.5 Extracting the casting/molded part
2.3.1.5.1 Destroying the mold
2.3.1.5.2 Open the mold/ejecting
2.3.2 Forming
2.3.2.1 Selecting the shaping device
2.3.2.1.1 Die/Form/Mold
2.3.2.1.1.1 Open
2.3.2.1.1.2 Mated (closed)
2.3.2.1.1.3 One-piece shaped
2.3.2.1.2 Roll

2.3.2.1.2.1 Straight/smooth
2.3.2.1.2.2 Shaped
2.3.2.2 Determining material temperature
2.3.2.2.1 Hot forming
2.3.2.2.2 Cold forming
2.3.2.3 Producing forming forces (sources of pressure)
2.3.2.3.1 Machine tool
2.3.2.3.1.1 Press
2.3.2.3.1.2 Hammer
2.3.2.3.1.3 Rolling mill
2.3.2.3.1.4 Draw bench
2.3.2.3.2 Other
2.3.2.3.2.1 Air pressure
2.3.2.3.2.2 Vacuum
2.3.2.3.2.3 High energy rate (HER)
2.3.3 Separating
2.3.3.1 Selecting the cutting element
2.3.3.1.1 Single point tool
2.3.3.1.2 Multiple-point tool
2.3.3.1.2.1 Symmetrical
2.3.3.1.2.2 Random
2.3.3.1.3 Other
2.3.3.1.3.1 Sound
2.3.3.1.3.2 Flame
2.3.3.1.3.3 Electrical spark
2.3.3.1.3.4 Chemical
2.3.3.1.3.5 Other
2.3.3.2 Generating feed and cutting motion
2.3.3.2.1 Reciprocating
2.3.3.2.1.1 Work
2.3.3.2.1.2 Cutting element
2.3.3.2.2 Rotating
2.3.3.2.2.1 Work
2.3.3.2.2.2 Cutting element
2.3.3.2.3 Linear
2.3.3.2.3.1 Work
2.3.3.2.3.2 Cutting element
2.3.3.3 Clamping cutting elements and work
2.3.3.3.1 Cutting element clamping
2.3.3.3.2 Work clamping
2.3.4 Conditioning
2.3.4.1 Chemical conditioning
2.3.4.1.1 Fermentation
2.3.4.1.2 Crystallization
2.3.4.1.3 Polymerization
2.3.4.2 Thermal conditioning
2.3.4.2.1 Heat treating/firing
2.3.4.2.2 Melting
2.3.4.2.3 Freezing
2.3.4.2.4 Drying

2.3.4.3 Mechanical conditioning (Work hardening)
2.3.5 Assembling
2.3.5.1 Bonding
2.3.5.1.1 Selecting bonding agents
2.3.5.1.1.1 Same material
2.3.5.1.1.2 Similar material
2.3.5.1.1.3 Different material
2.3.5.1.2 Selecting bonding method
2.3.5.1.2.1 Fusion bonding
2.3.5.1.2.2 Flow bonding
2.3.5.1.2.3 Pressure bonding
2.3.5.1.2.4 Cold bonding
2.3.5.1.2.5 Adhesive bonding
2.3.5.1.3 Selecting joints
2.3.5.1.3.1 Tee
2.3.5.1.3.2 Corner
2.3.5.1.3.3 Butt
2.3.5.1.3.4 Skarf
2.3.5.1.3.5 Lap
2.3.5.2 Mechanical Fastening
2.3.5.2.1 Selecting the fastening agent
2.3.5.2.1.1 Mechanical fastening
2.3.5.2.1.2 Mechanical force
2.3.5.2.2 Installing fasteners
2.3.6 Finishing
2.3.6.1 Selecting the finishing material
2.3.6.1.1 Converted surfaces
2.3.6.1.2 Coatings
2.3.6.1.2.1 Organic
2.3.6.1.2.2 Inorganic
2.3.6.2 Preparing the material to be finished
2.3.6.2.1 Deburring
2.3.6.2.2 Mechanical cleaning
2.3.6.2.3 Chemical cleaning
2.3.6.3 Applying finishes
2.3.6.3.1 Chemical techniques
2.3.6.3.2 Mechanical techniques
2.3.6.3.2.1 Brushing
2.3.6.3.2.2 Rolling
2.3.6.3.2.3 Spraying
2.3.6.3.2.4 Dipping
2.3.6.3.2.5 Curtain coating (flowing)
2.3.6.3.3 Electrical techniques

3.0 Managerial Processes
3.1 Managerial functions
3.1.1 Planning
3.1.1.1 Determining objectives
3.1.1.2 Forecasting

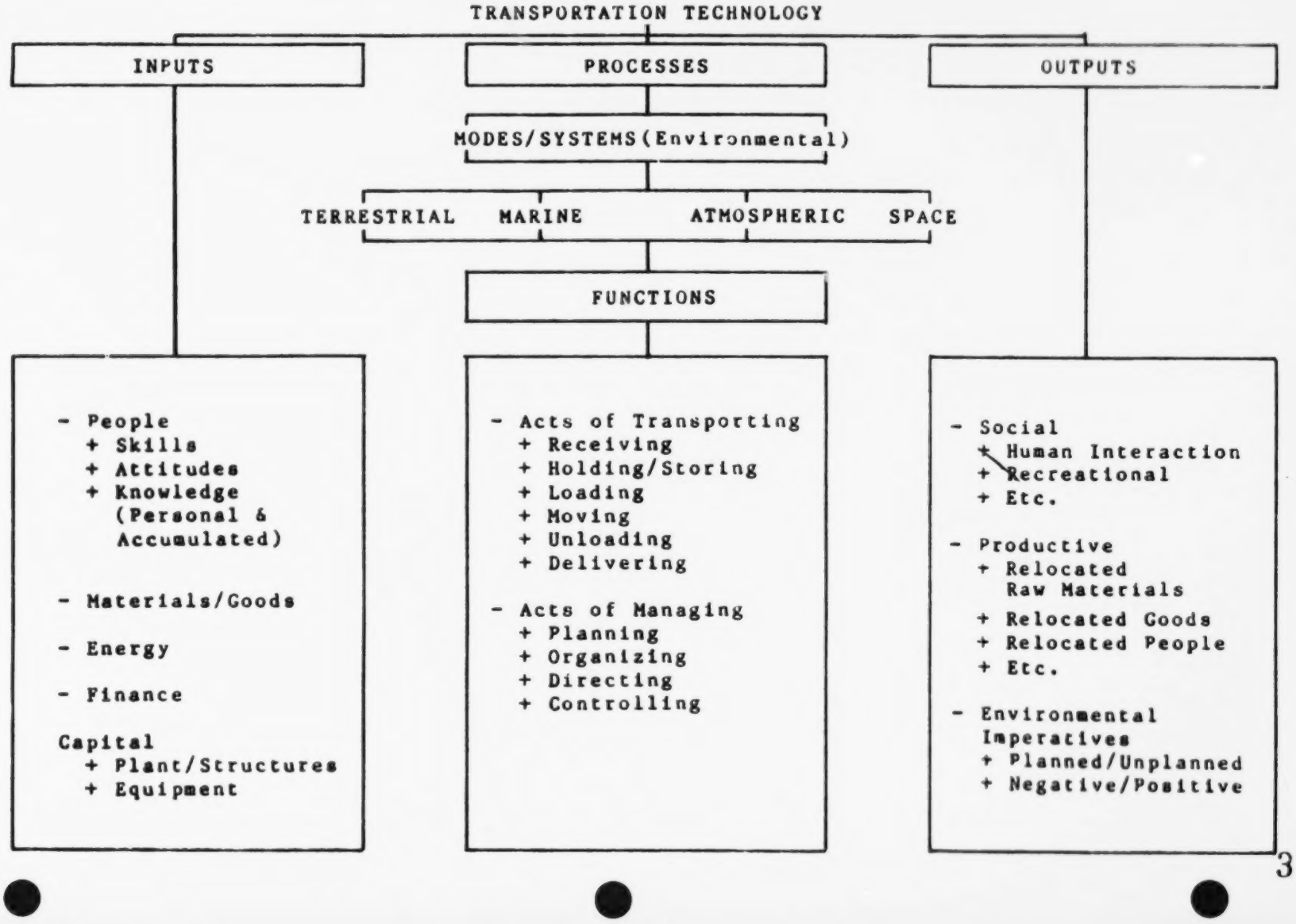
3.1.1.3 Establishing tasks for each objective
3.1.1.4 Developing procedures for meeting tasks
3.1.1.5 Developing policies
3.1.2 Organizing
3.1.2.1 Developing chains of command
3.1.2.2 Specifying position tasks and requirements
3.1.2.3 Staffing positions
3.1.3 Actuating (directing)
3.1.3.1 Issuing work orders and directions
3.1.3.2 Motivating employees
3.1.3.3 Communicating goals, work requirements, etc.
3.1.3.4 Rewarding appropriate preformance
3.1.4 Controlling
3.1.4.1 Comparing results with plans
3.1.4.2 Suggesting corrective action
3.1.4.3 Reporting preformance results
3.2 Types of managed production systems
3.2.1 Custom
3.2.2 Intermittent
3.2.2.1 Job-lot
3.2.2.2 Batch
3.2.3 Continuous
3.3 Managed System Activities
3.3.1 Establishing the organization
3.3.1.1 Generating capital
3.3.1.2 Structuring the organization
3.3.1.3 Employing managerial personnel
3.3.2 Designing the product
3.3.2.1 Researching
3.3.2.2 Developing
3.3.2.3 Product engineering
3.3.3 Preparing to produce the product
3.3.3.1 Manufacturing engineering
3.3.3.2 Production planning and control
3.3.3.3 Employing production personnel
3.3.3.4 Training
3.3.3.5 Procuring/purchasing
3.3.4 Producing the product
3.3.4.1 Processing materials
3.3.4.2 Controlling quality
3.3.4.3 Establishing safety programs
3.3.4.4 Providing employee services
3.3.4.5 Administering wages and salaries
3.3.5 Delivering the product
3.3.5.1 Advertising
3.3.5.2 Selling
3.3.5.3 Distributing
3.3.6 Servicing the product

3.3.6.1 Installing
3.3.6.2 Maintaining
3.3.6.3 Diagnosing
3.3.6.4 Repairing
3.3.6.5 Testing
3.3.6.6 Modifying
3.3.7 Controlling the system
3.3.7.1 Monitoring
3.3.7.2 Assessing
3.3.7.3 Reporting
3.3.7.4 Altering

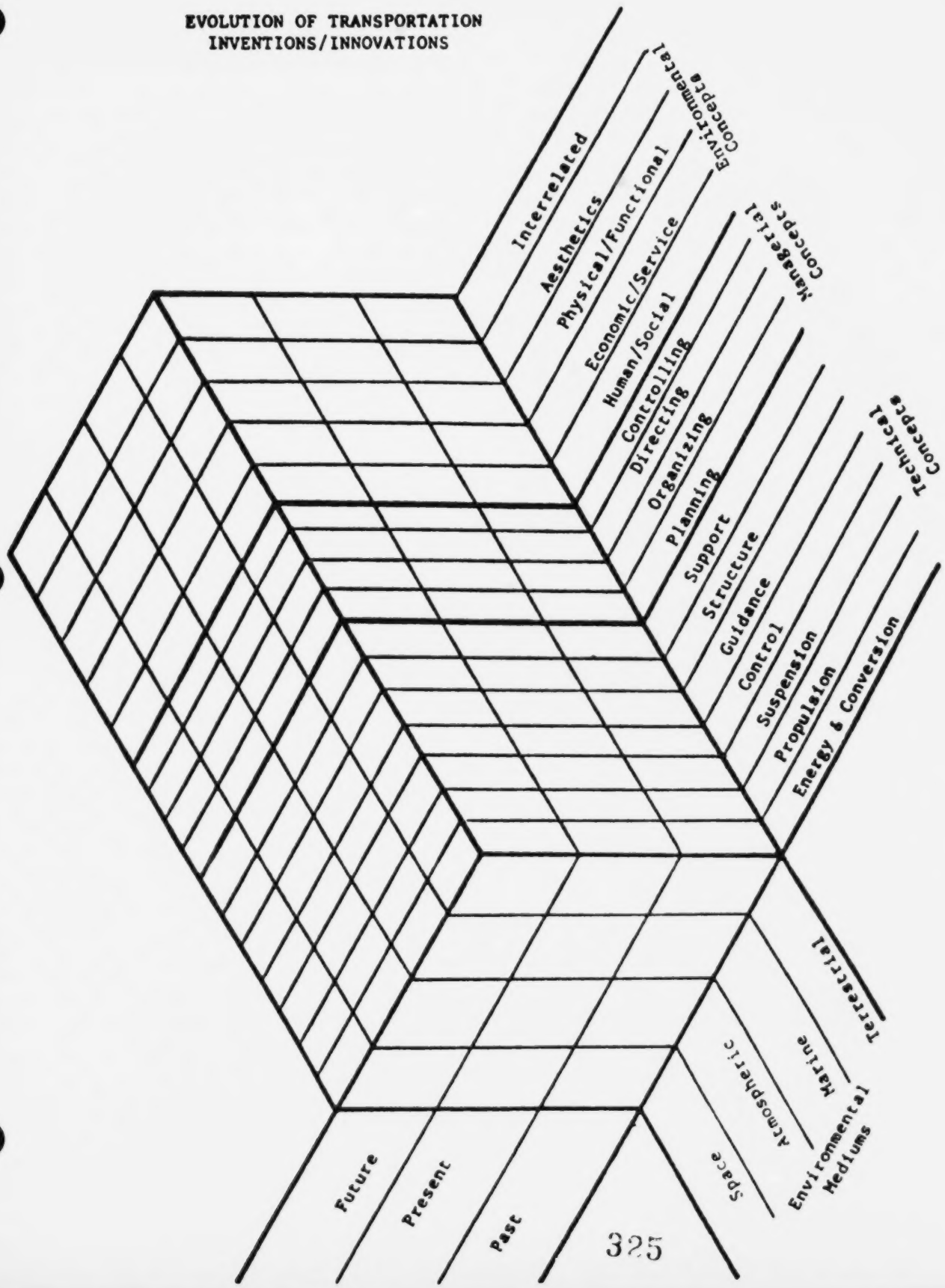
4 Manufacturing Outputs
4.1 Primary outputs
4.1.1 Raw Materials
4.1.1.1 State
4.1.1.1.1 Liquid
4.1.1.1.2 Gas
4.1.1.1.3 Solid
4.1.1.2 Properties
4.1.1.2.1 Mechanical
4.1.1.2.2 Physical
4.1.1.2.3 Chemical
4.1.1.2.4 Thermal
4.1.2 Industrial Goods
4.1.2.1 Types
4.1.2.1.1 Polymeric
4.1.2.1.2 Metallic
4.1.2.1.3 Ceramic
4.1.2.1.4 Composite
4.1.2.2 Properties
4.1.2.2.1 Mechanical
4.1.2.2.2 Physical
4.1.2.2.3 Chemical
4.1.2.2.4 Electrical/Mechanical
4.1.2.2.5 Optical
4.1.2.2.6 Accoustical
4.1.3 Finished Goods
4.1.3.1 Classes
4.1.3.1.1 Consumer
4.1.3.1.2 Industrial
4.1.3.1.3 Military
4.1.3.2 User selection criteria
4.1.3.2.1 Appearance
4.1.3.2.2 Function
4.1.3.2.3 Economic Value
4.1.3.2.4 Status Value
4.1.3.2.5 Environmental impact

4.2 Other outputs
- 4.2.1 Scrap
  - 4.2.1.1 Recyclable
  - 4.2.1.2 Waste
- 4.2.2 Pollution
  - 4.2.2.1 Air
  - 4.2.2.2 Water
  - 4.2.2.3 Land/soil
  - 4.2.2.4 Ecocycle
  - 4.2.2.5 Noise

TRANSPORTATION TAXONOMIES


TRANSPORTATION TECHNOLOGY
INPUTS
PROCESSES
OUTPUTS
MODES/SYSTEMS(Environmental)
TERRESTRIAL
MARINE
ATMOSPHERIC
SPACE
FUNCTIONS
- People
+ Skills
+ Attitudes
+ Knowledge (Personal & Accumulated)
- Materials/Goods
- Energy
- Finance
Capital
+ Plant/Structures
+ Equipment
- Acts of Transporting
+ Receiving
+ Holding/Storing
+ Loading
+ Moving
+ Unloading
+ Delivering
- Acts of Managing
+ Planning
+ Organizing
+ Directing
+ Controlling
- Social
+ Human Interaction
+ Recreational
+ Etc.
- Productive
+ Relocated Raw Materials
+ Relocated Goods
+ Relocated People
+ Etc.
- Environmental Imperatives
+ Planned/Unplanned
+ Negative/Positive

TRANSPORTATION TECHNOLOGY -- INFRASTRUCTURE



1 Technological Base
- 1.1 Elements of Transportation
  - 1.1.1 Human Mobility
  - 1.1.2 Activity (Movement of Goods and People)
  - 1.1.3 Physical (Natural and Man-Made)
- 1.2 Conquest of Time and Space
- 1.3 Foundational Developments
  - 1.3.1 Inventions
  - 1.3.2 Innovation
- 1.4 Transportation Systems (People)
  - 1.4.1 Personalized (Individual)
    - 1.4.1.1 Random Route
    - 1.4.1.2 Fixed Route
  - 1.4.2 Mass Transit
    - 1.4.2.1 Random Route
    - 1.4.2.2 Fixed Route
- 1.5 Transportation Systems (Materials and Goods)
  - 1.5.1 Natural Forms of Movement
  - 1.5.2 Technologies of Transport
    - 1.5.2.1 Containers
    - 1.5.2.2 Vehicles
    - 1.5.2.3 Terminals
    - 1.5.2.4 Pathways
- 1.6 Environment Mediums
  - 1.6.1 Terrestrial
  - 1.6.2 Marine
  - 1.6.3 Atmospheric
  - 1.6.4 Space
  - 1.6.5 Interrelated

2 Acts of Transporting
- 2.1 Receiving (People/Materials and Goods)
  - 2.1.1 People (Personalized and Mass Transit)
    - 2.1.1.1 Terminal (Multi-Modal Interface Facility)
    - 2.1.1.2 Station (Bi-Modal Interface Facility)
    - 2.1.1.3 Random and Fixed Points
  - 2.1.2 Materials/Goods (Bulk, Gross, Packaged)
    - 2.1.2.1 Terminal (Multi-Modal Interface Facility)
    - 2.1.2.2 Warehouse (Bi-Modal Receiving Facility)
    - 2.1.2.3 Random/Fixed Points
- 2.2 Holding/Storing
  - 2.2.1 People (Personalized and Mass Transit)
    - 2.2.1.1 Terminal
    - 2.2.1.2 Station (Intermodal)
    - 2.2.1.3 Random/Fixed Point (Intra-Modal)
  - 2.2.2 Material/Goods (Bulk, Gross, Packaged)
    - 2.2.2.1 Terminal
    - 2.2.2.2 Warehouse
    - 2.2.2.3 Random/Fixed Points
- 2.3 Loading (People/Materials and Goods)
  - 2.3.1 Manual
  - 2.3.2 Mechanical (Manually Operated)

2.3.3 Mechanized
2.3.3.1 Semi-Automated
2.3.3.2 Automated
2.3.4 Hybrid
2.4 Moving of Goods/Materials/People
2.4.1 Terrestrial Modes & Systems (Personalized-Individual Mass)
2.4.1.1 Human Locomotion
2.4.1.2 Carts & Wagons
2.4.1.3 Railways
2.4.1.3.1 Conventional Surface Rail
2.4.1.3.2 Subsurface Rail
2.4.1.3.3 Elevated Rail
2.4.1.3.4 Trolley-Rail
2.4.1.4 Personal Rapid Transit
2.4.1.5 Bicycle
2.4.1.6 Motorcycle
2.4.1.7 Automobile
2.4.1.8 Bus
2.4.1.9 Snowmobile
2.4.1.10 Special Purpose
2.4.1.10.1 Elevators
2.4.1.10.2 Escalators
2.4.1.10.3 Moving Sidewalks
2.4.1.11 Tube Transportation
2.4.1.12 Multi-Modal
2.4.2 Terrestrial Modes & Systems (Cargo--Bulk/Unit)
2.4.2.1 Railway
2.4.2.2 Truck
2.4.2.3 Continuous Capacity Systems (Stationary)
2.4.2.3.1 Conveyors (Mechanical/Pneumatic)
2.4.2.3.2 Pipelines
2.4.3 Marine Modes and Systems
2.4.3.1 Inland Waterways
2.4.3.1.1 Canals
2.4.3.1.2 Rivers
2.4.3.1.3 Lakes
2.4.3.1.4 Coastal
2.4.3.2 Transoceanic Maritime
2.4.3.2.1 Canals
2.4.3.2.2 Oceans
2.4.3.3 Marine Modes (Personal/Mass & Bulk/Units)
2.4.3.3.1 Canoe
2.4.3.3.2 Power Boat
2.4.3.3.3 Sail Boat
2.4.3.3.4 Raft
2.4.3.3.5 Barge
2.4.3.3.6 Towboat
2.4.3.3.7 Tugboat
2.4.3.3.8 Hydrofoil Vessel
2.4.3.3.9 Hovercraft Vessel

2.4.3.3.10 Container Ship
2.4.3.3.11 Tanker
2.4.3.3.12 Freighter
2.4.3.3.13 Aircraft Carrier
2.4.3.3.14 Ocean Liner
2.4.3.3.15 Merchant Ship
2.4.3.3.16 Battleship
2.4.3.3.17 Cruiser
2.4.3.3.18 Submarine

2.4.4 Atmospheric Modes & Systems (People and Goods)
2.4.4.1 Lighter-Than-Air
2.4.4.1.1 Rigid Airship
2.4.4.1.2 Semi-Rigid Airship
2.4.4.1.3 Balloon
2.4.4.2 Heavier-Than-Air
2.4.4.2.1 Conventional Aircraft (Passenger)
2.4.4.2.2 Helicopter
2.4.4.2.3 Military Aircraft
2.4.4.2.4 Special Purpose Aircraft
2.4.4.2.5 Cargo Aircraft

2.4.5 Space Modes and Systems
2.4.5.1 Manned Space Vehicles
2.4.5.1.1 Spacecraft
2.4.5.1.2 Space Shuttle
2.4.5.2 Unmanned Space Vehicles
2.4.5.2.1 Missiles
2.4.5.2.2 Launch Vehicles
2.4.5.2.3 Satellites
2.4.5.2.4 Space Probes

2.5 Unloading
2.5.1 Automated/Mechanized
2.5.2 Manual/Mechanized
2.5.3 Manual
2.5.4 Hybrid

2.6 Delivering
2.6.1 Means of Delivering To Final Destination
2.6.1.1 Self-locomotion
2.6.1.2 Fixed Route to Random
2.6.1.3 Check-in/Receiving

3 Technical Systems
3.1 Energy Sources and Conversion
3.1.1 Energy Sources
3.1.1.1 Electrical
3.1.1.2 Chemical
3.1.1.3 Kinetic
3.1.1.4 Gravity
3.1.1.5 Mechanical
3.1.1.6 Magnetic
3.1.1.7 Solar
3.1.1.8 Nuclear

- 3.1.2 Conversion Systems
  - 3.1.2.1 Internal Combustion
  - 3.1.2.2 External Combustion
  - 3.1.2.3 Hybrid Systems
    - 3.1.2.3.1 Mechanical/Mechanical
    - 3.1.2.3.2 Chemical/Chemical
    - 3.1.2.3.3 Electrical/Mechanical
    - 3.1.2.3.4 Chemical/Electrical

3.2 Propulsion Systems
- 3.2.1 Mechanical Drive System
- 3.2.2 Hydraulic Drive Systems
- 3.2.3 Electric Drive System
  - 3.2.3.1 Generator/Motor (Rotary)
  - 3.2.3.2 Linear Induction
- 3.2.4 Vacuum
- 3.2.5 Gravity
- 3.2.6 Reaction
  - 3.2.6.1 Water Jet
  - 3.2.6.2 Air Reaction
  - 3.2.6.3 Rocket (Liquid/Solid)
- 3.2.7 Storage Devices

3.3 Suspension Systems
- 3.3.1 Mechanical Suspension
  - 3.3.1.1 Wheel on Surface
  - 3.3.1.2 Wheel on Rail
  - 3.3.1.3 Wheel on Guideway
  - 3.3.1.4 Monorail Systems
  - 3.3.1.5 Sliding Devices
- 3.3.2 Fluid Suspension
  - 3.3.2.1 Aerostatic Lift
    - 3.3.2.1.1 Air Cushion
    - 3.3.2.1.2 Air Film
  - 3.3.2.2 Hydrostatic
  - 3.3.2.3 Hydrodynamic
    - 3.3.2.3.1 Foil
    - 3.3.3.3.2 Lift
  - 3.3.2.4 Aerodynamic
- 3.3.3 Magnetic Suspension
  - 3.3.3.1 Permanent Magnet
  - 3.3.3.2 Electromagnet

3.4 Control Systems (Degrees of Freedom)
- 3.4.1 Velocity Control
  - 3.4.1.1 Acceleration
  - 3.4.1.2 Deceleration
  - 3.4.1.3 Breaking
- 3.4.2 Directional Control
- 3.4.3 Attitude Control
- 3.4.4 Altitude Control
- 3.4.5 Vehicular and System Control
  - 3.4.5.1 Manually
  - 3.4.5.2 Remotely
  - 3.4.5.3 Regulatory

- 3.5 Guidance Systems
  - 3.5.1 Guideway Systems
    - 3.5.1.1 Highway
    - 3.5.1.2 Rail Flange
    - 3.5.1.3 Tube
    - 3.5.1.4 Canal
    - 3.5.1.5 Cable
    - 3.5.1.6 Monorail
  - 3.5.2 On-Board and External Guidance Devices/System
    - 3.5.2.1 Sensing Systems
    - 3.5.2.2 Encoding Systems
    - 3.5.2.3 Transmitting Systems
    - 3.5.2.4 Signalling Systems
    - 3.5.2.5 Receiving Systems
    - 3.5.2.6 Decoding Systems
    - 3.5.2.7 Storing Systems
    - 3.5.2.8 Retrieval Systems
  - 3.5.3 Interrelationship of Guidance and Control Systems
- 3.6 Structural Systems
  - 3.6.1 Vehicular--Design Considerations
    - 3.6.1.1 Human Factors
    - 3.6.1.2 Safety
    - 3.6.1.3 Environmental
    - 3.6.1.4 Performance
    - 3.6.1.5 Economic Factors
  - 3.6.2 Guideway Structures - Design Consideration
    - 3.6.2.1 Railways
    - 3.6.2.2 Monorails
    - 3.6.2.3 Cableways
    - 3.6.2.4 Beltways
    - 3.6.2.5 Roadways
    - 3.6.2.6 Bridges
    - 3.6.2.7 Tunnels/Canals
    - 3.6.2.8 Airport Runways
  - 3.6.3 Support System -- Structures
    - 3.6.3.1 Terminals
    - 3.6.3.2 Maintenance/Service
    - 3.6.3.3 Roadside Rest Areas
    - 3.6.3.4 Harbors
    - 3.6.3.5 Loading/Unloading Docks
    - 3.6.3.6 Storage Facilities
    - 3.6.3.7 Parking Lots and Ramps
- 3.7 Support Systems
  - 3.7.1 Physical Facilities -- Design Factors
    - 3.7.1.1 Ticket offices/Reservations
    - 3.7.1.2 Harbors/Docks
    - 3.7.1.3 Parking Facilities
    - 3.7.1.4 Intermodal Interfaces
    - 3.7.1.5 Baggage Handling
    - 3.7.1.6 Other

- 3.7.2 Personnel
  - 3.7.2.1 Selection
  - 3.7.2.2 Training/Education
  - 3.7.2.3 Career Opportunities
  - 3.7.2.4 Economic Factors
- 3.7.3 Systems Regulatory Factors
  - 3.7.3.1 Laws and Regulations
  - 3.7.3.2 Licensing
  - 3.7.3.3 Enforcement
- 3.7.4 Operational Systems
  - 3.7.4.1 Traffic Management
  - 3.7.4.2 Scheduling
  - 3.7.4.3 Routes and Routing

4 Environmental Factors

- 4.1 Human/Social
  - 4.1.1 Safety
  - 4.1.2 Human Values and Desires
  - 4.1.3 Enhancement of Social, Recreational, Cultural Programs and Facilities.
  - 4.1.4 Comfort/Convenience
  - 4.1.5 Demand Responsiveness
  - 4.1.6 Service for Handicapped and Elderly
  - 4.1.7 Privacy
- 4.2 Economic/Service
  - 4.2.1 Transportation Costs
  - 4.2.2 Access to Employment Opportunities
  - 4.2.3 Efficiency
- 4.3 Physical and Functional
  - 4.3.1 Effects on Land Use
  - 4.3.2 Adaptable to Future Needs
  - 4.3.3 Flexibility
  - 4.3.4 Adaptable to Intermode Operation
- 4.4 Aesthetics
  - 4.4.1 General Appearance in Relationship to Surrounding Environment
  - 4.4.2 Conservation of Natural Resources
- 4.5 Interrelated
  - 4.5.1 Level of Noise
  - 4.5.2 Air and/or Water Pollution Characteristics
  - 4.5.3 Neighborhood Growth and Development
  - 4.5.4 Accessibility

A P P E N D I X B

A Base for Curriculum Derivation

from

Snyder, James F. and Hales, James A. (Ed.).
Jackson's Mill Industrial Arts Curriculum
Charleston: West Virginia Department of Education, 1981.

APPENDIX B

A BASE FOR CURRICULUM DERIVATION

SOCIETY AND CULTURE

The relationship between human beings and their social and natural environment has changed significantly since the beginning of civilization. The quality of the human condition and the survival of the human species has been determined over the last million or so years, not so much by the resources available or the social climate in which humans lived, but by the development and use of tools, machines, materials, and techniques.

With the evolution of new forms of socio-technological organizations and the development of tools, machines, materials, and techniques, it became obvious that technology was a total system composed of many elements and subsystems, each critical to the functioning of the whole. This is a new perspective, a new way of perceiving technology and technical development.

What were once separate crafts, trades, or enterprises with one-dimensional relationships have become systems or subsystems with multidimensional relationships. Emerging from this new perspective have been four distinct, yet interrelated and interdependent industrial/technological systems: communication, construction, manufacturing, and transportation. Each of these systems and their subsystems has been in existence at some level of development throughout the history of civilization. Each has a central theme, is universal in all societies, has unique questions

and problems, and contributes in some way to the survival and potential of human beings. Creative endeavors in each of these primary technical systems have brought about new choices as well as new problems for human beings.

New developments in the technical means of communicating, constructing, manufacturing, and transporting can cause social change. The accumulation of a more sophisticated and potentially destructive technical means, often with global impact, has forced people to recognize that continued acceptance of new technical means without the assessment of the impact of these means on people, the social order, and environment can no longer be tolerated.

It is evident that our collective human actions, using more powerful and potentially destructive technical means within a finite and fragile environment, can result in consequences detrimental to continued human evolution and development. Choices made today about the nature of our technical means legislate the future, sometimes irreversibly, such as chemical dumps, highway construction or the use of pesticides.

To counter this self-destructing movement locally, nationally, and globally requires intelligent human action control adaptive systems which have until recently provided our survival potential. These same systems have the potential of becoming destructive to human beings and social purpose. The solution to this problem is the control of our technical systems for the human social purpose. This will require an understanding of the behavior of these systems and the relation of these systems to human beings, their social purpose, and the environment.

DOMAINS OF KNOWLEDGE

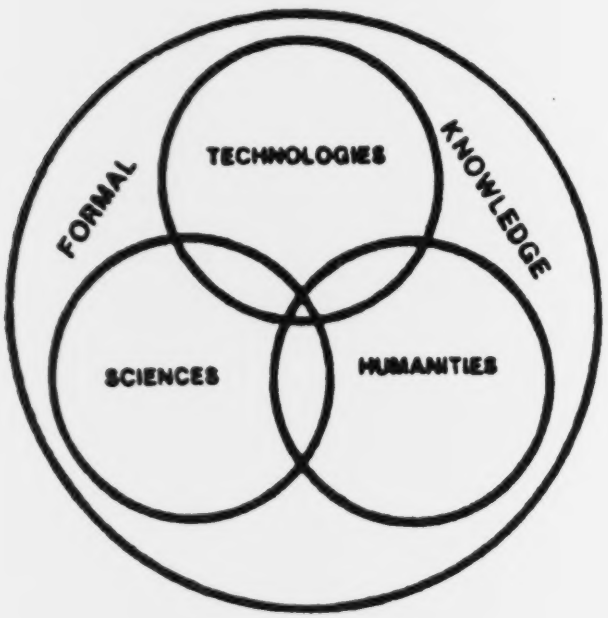
Scholars throughout the ages have identified, codified,

and recorded knowledge which enables humans to adapt to the environment in which they must live. Such knowledge passes from generation to generation through genetics but mainly through that socialization process we call learning. The cognitive perceptions we have of our total environment make up what we call knowledge. The context of that knowledge is based on what has happened, but the function of knowledge is definitely prospective. Knowledge gives us an understanding of what was, what is, and what can be. Humans seek higher forms of knowledge that they can apply to their environment.environment.

Knowledge throughout the ages has been provided with a syntactical and conceptual structure to make it useful for continued manipulation of the natural and human-made environment. Scholars find it efficient and useful to separate bodies of knowledge into disciplines. Yet different disciplines focus their attention on the same phenomena and issues. Those natural phenomena, human/social activity, or other aspects of human concern on which all members of the several disciplines focus their attention constitute a domain. At the risk of over-simplification, we can say that conceptual activity and its recorded literature have been arrayed into what we call domains of knowledge.

As one might expect, there is not a consensus among scholars as to the designations or parameters of each domain. In some cases they are divided to meet the needs of specific groups, social classes, or global societies. The public schools, for example, have not reached consensus on the body of knowledge for the teaching/learning process. This does not imply chaos but diversity within each system.The domains selected by the Jackson's Mill Curriculum Symposium participants are based on the realization that cultural universals can be isolated for the purpose of analysis into four domains. These domains provide the

cognitive base for human adaption in the natural environment. The domains, as presented in Figure 1, are (1) sciences, (2) Humanities, (3) Technologies, and (4) Formal Knowledge. All domains are intrinsically linked. The fourth domain, formal knowledge, represented by linguistics, mathematics, and logic is a separate, distinct domain providing form and structure to the other three domains.



Domains of Knowledge

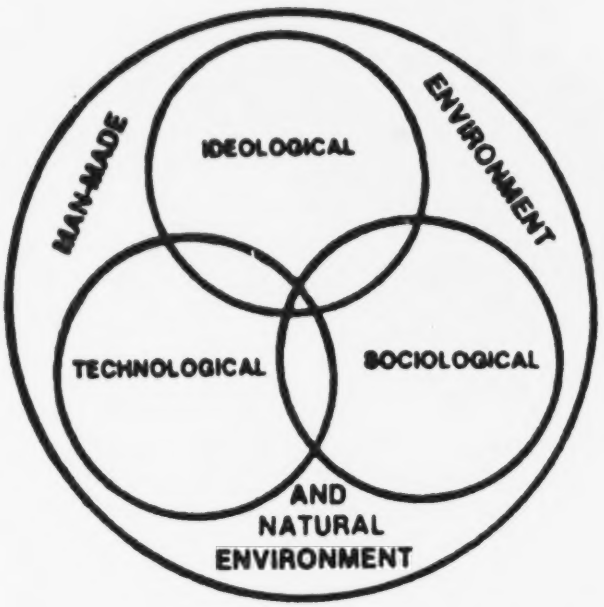
Figure 1

HUMAN ADAPTIVE SYSTEMS

The evolution of human beings and their social and technical orders can be understood by analyzing three human adaptive systems; the technological, sociological, and ideological. Ideological systems are concerned with the values and beliefs of society. Sociological systems are

patterns of societal endeavor, characterized by social organization and regulation. Technological systems pertain to the technical means of manipulating the physical world to meet basic needs of survival--food, clothing, shelter--as well as providing other goods, services, and means for extending human potential.

The three systems shown in Figure 2, Ideological, Sociological, and Technological, are interrelated and exist within a man-made/natural environment.

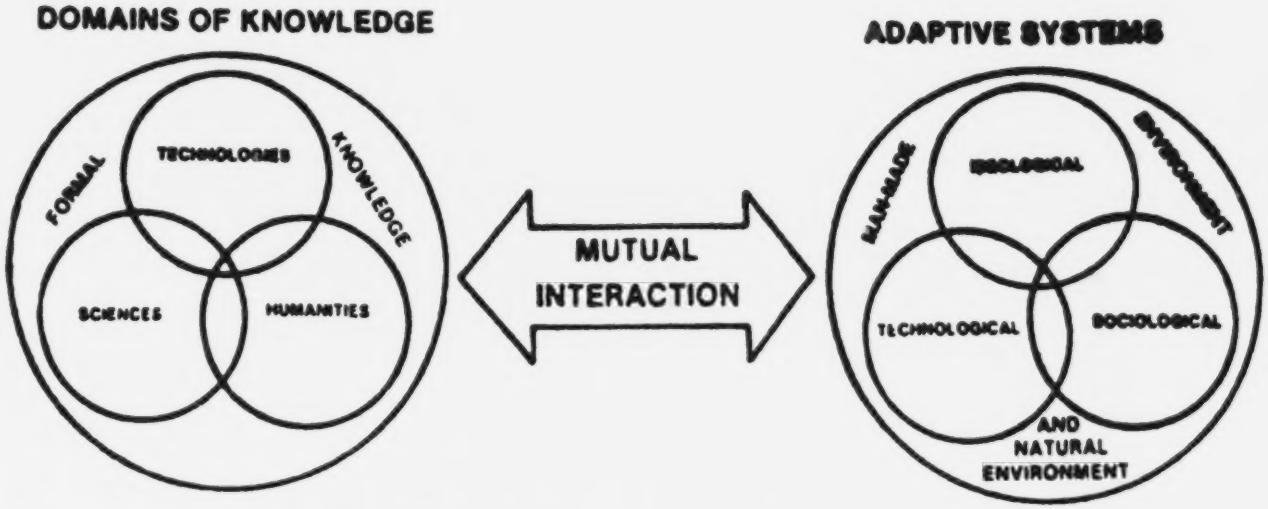


Human Adaptive Systems

Figure 2

It was further established that the domains of knowledge are interfaced with the three major human adaptive systems. Human adaptive systems mutually interact with the domains of knowledge and contribute to each other. This interaction is shown in Figure 3. Hence, as people discover

more knowledge, it helps them to adapt. As people develop better and improved ways to adapt, they contribute to the domains of knowledge.



Mutual Interaction Model

Figure 3

There is a fundamental rule of biology which states that an organism adapts to the environment in which it lives or becomes instinct. However, there are very few stable environments, even for animal life in the depths of the ocean. Life forms, therefore, must accept input, process that input, and modify behavior for survival. For humans, this is accomplished by processing knowledge and arranging it into new forms and adding new knowledge. This accumulation process provides the human with enormous power which must be used judiciously in order to eliminate negative results. Knowledge is indeed adaptive information. As people develop more knowledge, it helps them to adapt. Conversely, as they develop better ways to live, they contribute to the domains of knowledge.

Historically we can trace the adaptive process from basic biological forms to higher psychological and sociological forms. Constraints imposed by nature and other humans are mediated through the societal institutions created for that purpose. Thus, sociocultural systems emerge from the feedback exchanged between the various subsystems. Feedback provides self-regulation for the adaption process. The basis for this activity is communication.

The mutual interaction model presented in Figure 3 represents a system that is a complex of components related directly or indirectly in a casual network, with two or more components related to one another at any given moment. As a result, every adaptive system requires change as anecessary ingredient for survival. Survival is, therefore, dependent upon functional prerequisites. Each adaptive system discriminates, responds to data, and maps such information into its organization. As a result, the system becomes selectively related to the natural environment. The adaptive systems utilize knowledge and knowledge processes (e.g. learning, perception, limitation, thought, decision making) to create new knowledge.

All forms of life have constraints which require the ability to extend potential for survival. The human is no exception to this fact. Through the evolutionary process the human has gained the opposable thumb, stereoscopic eyesight, the ability to stand upright, and increased brain size, among other attributes. However, these biological adaptations have not been adequate to meet the needs for sustaining human life. Adaptations have been taking place to extend human potential for millions of years. The use of tools, techniques, resources, and knowledge to extend the human body exist in the adaptive system we call technology. The human continues this process and has advanced to a stage

that we refer to as the man-made environment and an industrial, technological society. As a result, it is imperative that the study of the adaptive system we call technology and the societal institution, industry, become paramount in the education of every student. At the same time, it is absolutely essential that the interaction among the adaptive systems (along with the interaction with the domains of knowledge) be integrated into the discipline we call Industrial Arts. The school is a microcosm of the totality of knowledge. Industrial arts represent a conscious effort to focus on the interaction between that knowledge and the adaptive systems we call technology and industry.

Each of the human adaptive systems interrelate on an individual, group, and institutional basis. In addition, each human adaptive system has an evolutionary development which is "internally unique." Yet, the system influences the other systems in its evolution.

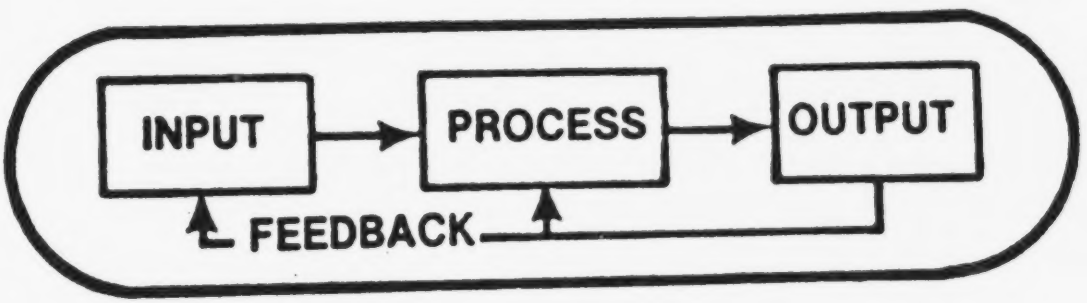
UNIVERSAL SYSTEMS MODEL

In coping with the problems of human existence, people have created societies that are diverse and complex. One problem confronting industrial arts teachers is how to sort out all of the components of human endeavor and classify them in a meaningful way.

Regardless of the categories that are finally identified and explicated (for educational purposes), it can be said about them that each category represents a "human adaptive system." That they are <u>human</u> separates them from those that exist in lesser forms of life. That they are <u>adaptive</u> implies that people constantly seek accommodation to their environment. That they are <u>systems</u> suggests there is some regularity to human adaptive behavior and that the elements of the system relate in orderly, pridictable ways.

A system involves combinations of elements or parts. When the parts of a system work together, they accomplish a desired goal.

To assist in understanding the construct system, a universal model of a system is presented in Figure 4.



Universal Systems Model

Figure 4

The "inputs" to the system provide all needed resources to accomplish The goals of the system. The "processes" are the means the appropriate means of bringing about system goals using the inputs (resources). The "outputs" of the system include the means or goals (products, services, or desired results) as they become parts of the newly accomodated environment within the sociocultural context.

The "process" portion of the model provides us with the boundaries of our unique discipline. Within the process boundaries are to be found the concepts, principles, generalizations, and unifying themes of technology (the knowledge of appropriate technical means). This qualifies our field of study to be considered as "process education." Other kinds of human knowledge are to be found in the "inputs" and "outputs" of a system.

System Inputs

To understand the universal systems model, the first element to be considered is "input." Six general classes of inputs need to be considered: (1) people, (2) knowledge, (3) materials, (4) energy, (5) capital, and (6) finance.

People: Human beings should be thought of as the most important input to the system. Without people, and their needs and wants, a human adaptive system would not exist. People bring to the system a varied background of knowledge, attitudes and skills that are needed to make the system work.

Knowledge: This major class of input exists within people or is retrieved or generated by people. It is so fundamental to the successful accomplishment of the ends (output) or goals of the system that this class of input needs additional explanation. People bring to the system the knowledge of the sciences and the knowledge of the humanities. Technological knowledge is generated by the system--the appropriate technical means to reach the desired goals of the system. Such technological knowledge would not exist if it were not for the existence and operation of each unique system. Knowledge of the biological, physical, and social sciences is critical, as well as the success of the system. Perhaps of most significance is the knowledge of the humanities, (e.g., ethics, morals, and values) as people investigate the very reasons for the existence and propagation of the system. Therefore, a human adaptive system is a self-correcting mechanism created by people to serve the will of the people.

Materials: Materials (e.g. iron ore, petroleum, paper) are inputs to a system that are used and/or processed. The supply of materials must be thought of as finite and their use carefully considered.

Energy: Most human activity requires energy sources beyond those of the human being. Like materials, energy must be carefully applied and consumed since certain energy sources are becoming depleted at an ever accelerating rate.

Capital: Systems need capital. Capital is defined as the buildings, machines, tools, and equipment that are needed to perform the processes of the system.

Finance: The last input to a system is finance or money. A system of exchange is needed to pay for all of the other required inputs. Therefore, money is used to buy the services of people, materials, energy, capital, and knowledge (data or information).

System Processes

The second major element of a system is "process." Each system of human endeavor has a scheme of actions or practices. This scheme may be referred to as the technical means of the system. The knowledge of these technical means is "technology."

The technical means would not have become systematized if the adaptive behavior had not been performed, imitated, and institutionalized through time. The processes of a system can be analyzed and structured into a meaningful sequence of purposeful action. Process may be considered as the appropriate means of developing products, services, or conditions (results) that are valued.

The impact of these technical means on society and culture must be carefully assessed. The assessment allows the system to function or to be modified. For example, if a manufacturing system disposes of its wastes in a careless manner, this activity should be terminated.

System Outputs

The third element of a system is "output." The output of a system is the goal (or ends) to which all of the inputs and the processes (technical means) are applied. These ends may be products, services, or other desired conditions within the environment. The goal of the system is to place people in harmony with their culture and society. The value of the outputs must be judged ultimately on the basis of their impact on the quality of life for the total world population.

A system requires assessment, adjustment, and constant redirection. There must be adequate feedback mechanisms to provide the preferred directions for the system.

Systems operate within the context of the ideological, sociological, and technological concerns of people. If a system functions to fulfill the best that people establish as their goals, progress for mankind will be assured.

THE ROLE OF SCHOOLING

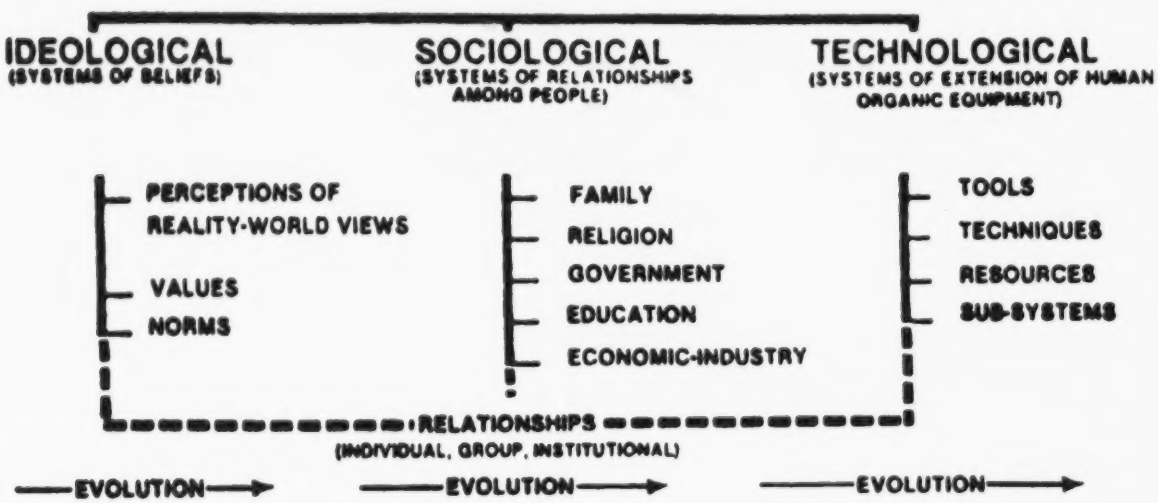
The study of industry and technology, with the goal of understanding and enhancing human potential, may be accomplished if a reasonably accurate and well defined model is derived from which curricular and programmatic decisions can be made. At issue is how to structure the study of industry and technology for basic or general education of all youth and adults.

Schooling should provide insight into the relationship of technical means to human beings, social purpose, and the environment. A study of human adaptive systems will contribute to such insight. To assist in the derivation of industrial arts curriculum, a model based upon human adaptive systems would be useful.

The approach to the study of our adaptive systems can

be from several perspectives. Whatever perspective is used must be compatible with the definition of industrial arts as determined for the purpose of this document. The focus must be on the human element--human endeavors in creating and using tools, techniques, resources, and systems to manage the human-made and natural environment for the purpose of extending human potential and the relationship of these to individuals, society, and the civilization process.

The approach to the study of adaptive systems, Figure 5, can be from a sociological perspective. In this context the focus would be on institutions including family, religion, government, education, and the economy. The



Adaptive Systems Components

Figure 5

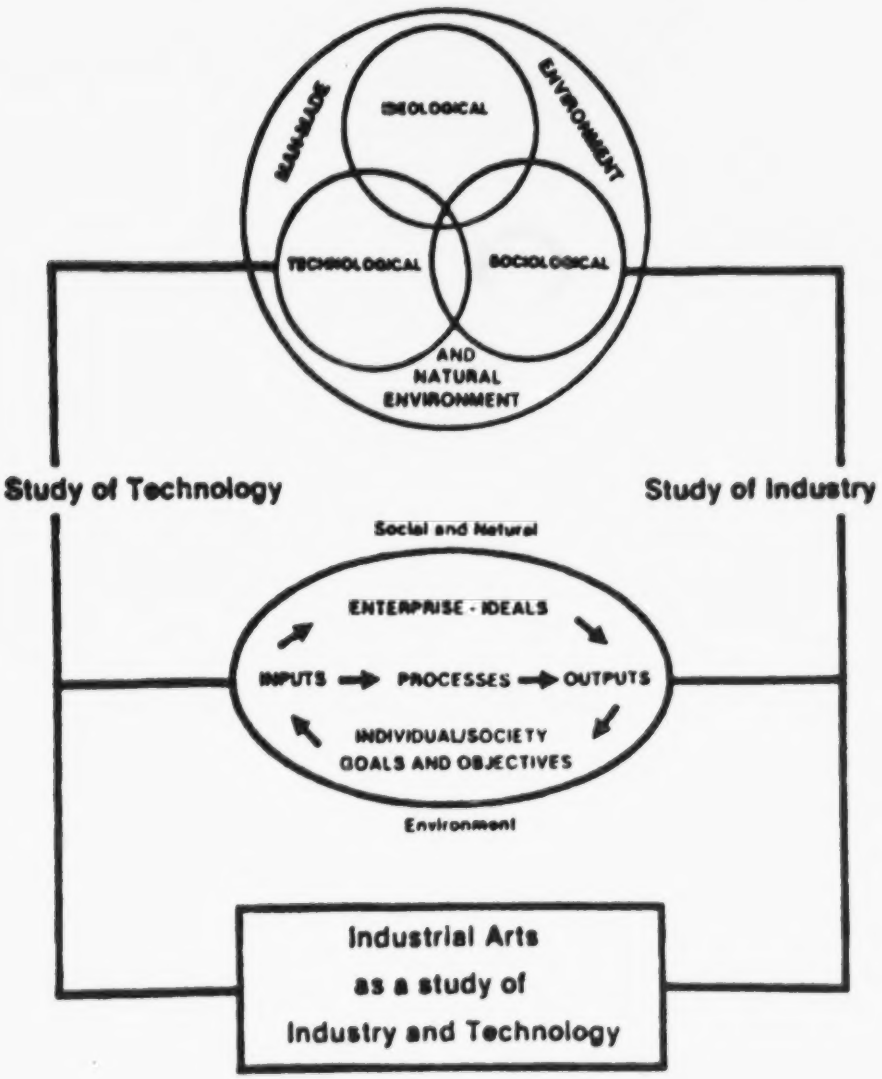
primary institution of concern to industrial arts has been industry. The study of adaptive systems from an industrial perspective would provide understanding and insight into the economic institution that appropriately utilizes resources to efficiently produce goods, services, and information to meet the needs and wants of individuals and society.

The study of adaptive systems can also be approached from an ideological perspective where the content would address values, beliefs, assessment, problems, issues, impacts, new knowledge structures, and perceptions of reality as well as new or future social directions. Studying adaptive systems may also be approached from the technological standpoint including: the means of producing food, clothing, shelter, and other material needs of society; communicating information; and transporting goods.

The universal technical systems which have evolved are communication, construction, manufacturing, and transportation--technical systems that are basic to every society. These systems are related to each other, but are unique in the types of questions and problems pursued and in their structure, concepts, and goals.

Each of these systems is related to the others in various degrees; the strength and magnitude of these relationships depend upon the focus of the systems involved. Similar essential relationships exist among the several adaptive systems: sociological, technical, and ideological. The magnitude and frequency of these relationships vary depending on the focus of these systems. For instance, there has generally been a more direct relationship between the study of sociological systems and technological systems than between the study of sociological and ideological systems. Likewise, the relationship between the study of technological systems and ideological systems is signigicant. It involves the evolution of the systems,

assessment of the technical means, and concern for the future of technical development with respect to social



A Model For Derivation of Curriculum

Figure 6

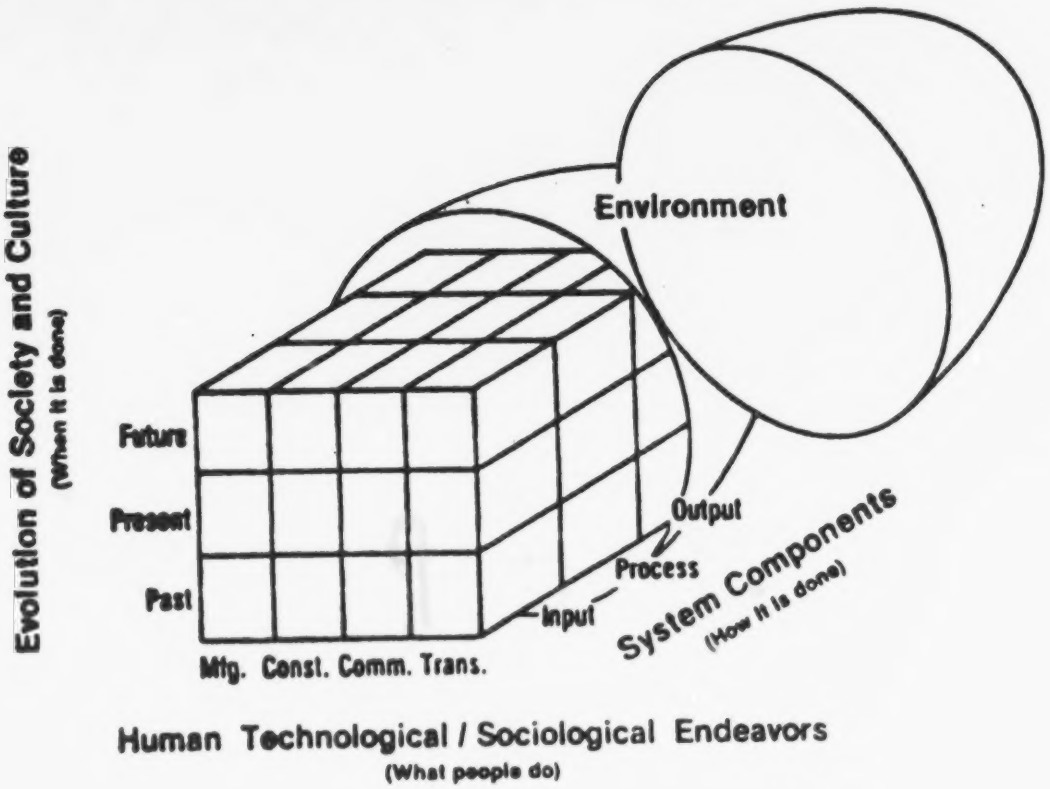
purpose. It is important to note that regardless of the system involved, or the focus of the study of the adaptive systems, all systems exist within a social and natural environment. This environment provides the conditions for the creation, the development, and the use (and limits of use) of technical means.

An analysis of this system of creative endeavor can be accomplished by use of the systems model described above: the input-process-output model. The relation of this model to the study of industry and technology is illustrated in Figure 6. The model provides a means for a curriculum base for industrial arts as a study of industry and technology. The universal systems model (input-process-output) recognizes the importance of both technical means and societal institutions in serving human needs and social purpose --Figure 4.

CURRICULUM THEORY

It is the function of curriculum theories to generate a bridge between the domains of knowledge and the teaching/learning process. The Curriculum Interaction Model,presented in Figure 7, utilizes the universal systems model in a unique relationship with the adaptive systems we call the technological/sociological adaptive systems. The model places emphasis on subject matter within human technological/sociological endeavors while providing an integration with the natural environment within a time demension. Each component of this activity functions within a system and subsystems which, by their very nature, rely on inputs, process these inputs, and produce specific outcomes (output). The model illustrates a concern for the integration of knowledge with emphasis placed on the discipline of industrial arts. The model has cognitive power, incorporates the affective dimension, while providing

ample opportunity for the development of psychomotor skills.



Curriculum Interaction Model

Figure 7

Throughout the development of industrial arts, many terms have been used to categorize or classify content. These terms have ranged from materials (e.g., woods, metals, plastics), to processes (e.g., drafting, graphic arts), to physical phenomena (e.g., energy, power), to technological systems (e.g., communication, manufacturing). This mixture of terms has caused leaders in the profession to search out a single, consistent principle for organizing curriculum content.

Traditional logic has provided a fundamental rule of classification. This rule suggests that some one aspect (single principle) of the "facts" must be adhered to for the entire classification. Thus, it would be a violation of the rule of the "single principle" to suggest that the content categories of industrial arts are drafting, woods, energy/power, and manufacturing, for example. Such a listing uses several organizers or ways of looking at content.

By developing a rationale that contends that the subject matter of industrial arts is involved with "appropriate technical means," set within the context of universal systems models of the ideological, sociological, and technological adaptive human systems, then the single organizing principle becomes "human endeavor." Hence, no division or category of subject matter may qualify for consideration unless it applies to human adaptive behavior.

Many potential structures have been proposed for the analysis of our technological systems. The one model which seems to be accepted nationally and internationally, recognizes four subsystems of human technological/sociological endeavor. These are communication, construction, manuacturing, and transportation. These relate to the physical technologies, distinct from other human activities, such as health care systems and defense systems, which use various technical means for monitoring the status of an accident victim or provide the means of transporting ordinance during times of national emergency.

The subject area of "power," or "energy/power," often suggested as a ma or division or principal category of industrial arts subject matter, simply does not qualify as "human endeavor." Energy is an input to all human adaptive systems and power is the output of mechanical systems designed to do work. Therefore, energy/power considerations should be organized and taught as integral to each of the

four major categories of adaptive behavior.

Human Technological/Sociological Endeavors

Within the identified subsystems we find both technical and sociocultural elements intrinsically linked to perpetuating the human race. The categories may appear in different forms depending upon the setting in which they exist. Whether we study the culture of the United States or third world countries, it is a fact that these categories exist. The technical components consist of the tools, resources, techniques, and systems. The socio-cultural components consist of individual and institutional responses for utilizing and responding to the technical means. This relationship is absolutely essential to human existence. Educating people within this context helps to ensure that individuals can make rational decisions concerning the adaptive subsystems they develop.

Evolution of Society and Culture

It was stated in a preceding section of this paper that knowledge is the body of information accrued through the ages. It is this reservoir of human input which provides a great deal of the input into curriculum development. The human has profited immeasurably from the lessons learned in the past. History broadens our perspective and reminds us that it is the human that must assume the responsibility for the condition of the natural and artificial environment. The technical and societal means that we utilize on a daily basis are the result of a lineage of ideas which have come from combining ideas and resources. Innovations do not surface from a void but rather from a lineage which must be comprehended in order to give us direction in the future.

The future of humankind is an unknown quantity. The future of a society could only be known in a perfectly

static society. In today's world, few societies, if any, escape the many transformations fostered by industrial/technological growth. These changes may vary in intensity among nations, but for the most part, surpass any in history in terms of speed and pervasiveness. It is apparent that some changes have come too fast, resulting in unforseen events. Today, as we transcend the industrial era, alternatives are not easily identified. Part of our problem in working within this context is that since the future does not exist, it cannot be studied. We can, however, study theories of what the world may be like. These theories are developed largely from what was, what is, and how we believe it is changing. The key element in this process is planning for futures that are appropriate for sustaining a human and humane life. In order to accomplish this, we utilize knowledge (past) and images of what we want (future) in our decision-making/action-taking systems (present).

Environment

At the present time, humans are restricted to the planet earth, which has finite limits. The use of industry and technology as adaptive systems requires vast amounts of natural resources which in many cases are irreplaceable. The survival of the human race is literally dependent upon an awareness of this as well as the decisions made within that context. Resources are not distributed evenly around the planet, making our global environment interdependent. Interdependence refers to the technical and socio-cultural context in which we ust live. Today's student must understand this microcosm and realize that individual and corporate decisions affect its existence. Survival requires responsible use of resources and technical means which raises value questions hat can only be answered realistically by an educated populace.

A BASE FOR CURRICULUM CONCEPTUALIZATION

THE CURRICULUM BASE

The content for industrial arts is drawn from the knowledge of the three systems of human adaptive behavior and human technical endeavors which exist to extend human potential. The subsystems of the human technical endeavor are communication, construction, manufacturing, and transportation. Each of these subsystems represent a discrete human endeavor which can be studied in isolation. For example, throughout history people have manufactured goods, constructed structures, communicated ideas, and transported goods and people.

Through human interaction in a given socio-cultural/physical environment, people have used knowledge, materials, finance, energy, and capital to design, engineer, implement, control, and reconceptualize the four subsystems to achieve the goals which are unique to the systems.

Whether for personal or societal reasons, an individual or a group of individuals may develop and use one or more of the systems to fulfill an economic need. Such needs include making a profit or a broader societal goal, such as creating a cleaner environment.

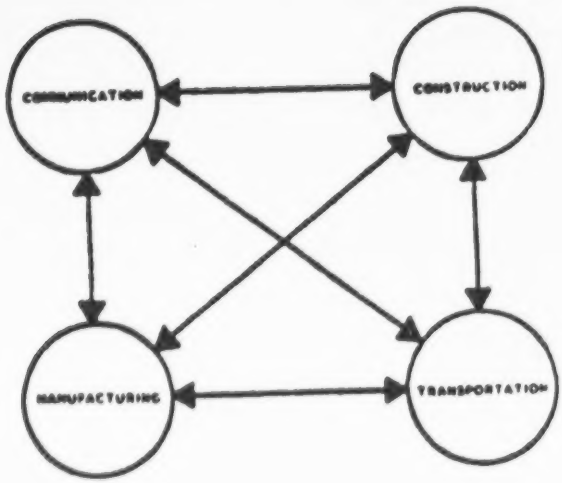
If the motivation for establishing the system is economic, the system is institutionalized. Unique goals are defined for the organization such as making a profit, staying in a particular business, expanding business operations, etc. The system may also contribute to broader societal objectives, such as providing goods and services,

enhancing the nation's prestige, increasing the individual's standard of living, providing for security and defense, etc.

Individuals may also use the system to meet personal goals such as building a structure, communicating a position on a given issue, manufacturing a piece of furniture, or transporting a family on a vacation.

The goods and services provided or produced by an organization may be used by individualspeople to fulfill personal needs (express themselves creatively, produce their own food, clothing, or shelter, etc.). The products of an organization may also be used to meet societal needs (save energy, provide a more wholesome environment, etc.). Hence, each of the subsystems represents a unique human endeavor defined by the nature of its activity. Each subsystem exists in a socio-cultural/natural environment to meet the goals of an economic institution and/or the goals of society.

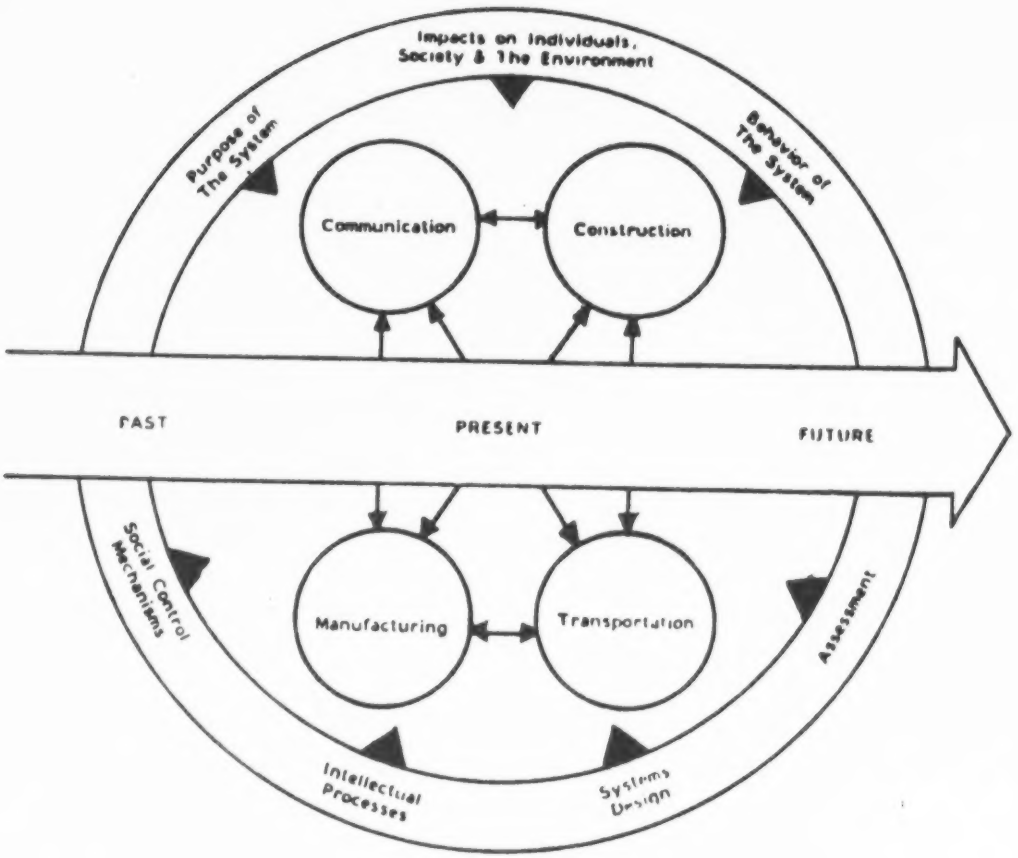
To properly understand the four subsystems, they must be viewed as they interrelate with each other. For example, manufactured goods are transported for wholesale and retail distribution; communication devices are developed and used as management tools for each of the four subsystems; and manufacturing is employed to produce materials, devices, and messages used by manufacturing, communication, construction, and transportation systems. This interrelationship is illustrated in Figure 8.



Interrelated Technical Adaptive Systems

Figure 8

Communication, construction, manufacturing, and transportation systems have common threads of similar organizational procedures, such as managed productive processes, and the interface among the four subsystems as well as with the other adaptive systems, Figure 9. While each subsystem exists to achieve specific goals and has a unique heritage, it is continually impacted by the natural/socio-cultural environment. Since each subsystem is developed, managed and implemented by individuals or groups of people, they experience a varied range of intellectual processes relative to analysis, synthesis, conceptualization, etc.



The Global Context of Human Technical Adaptive System

Figure 9

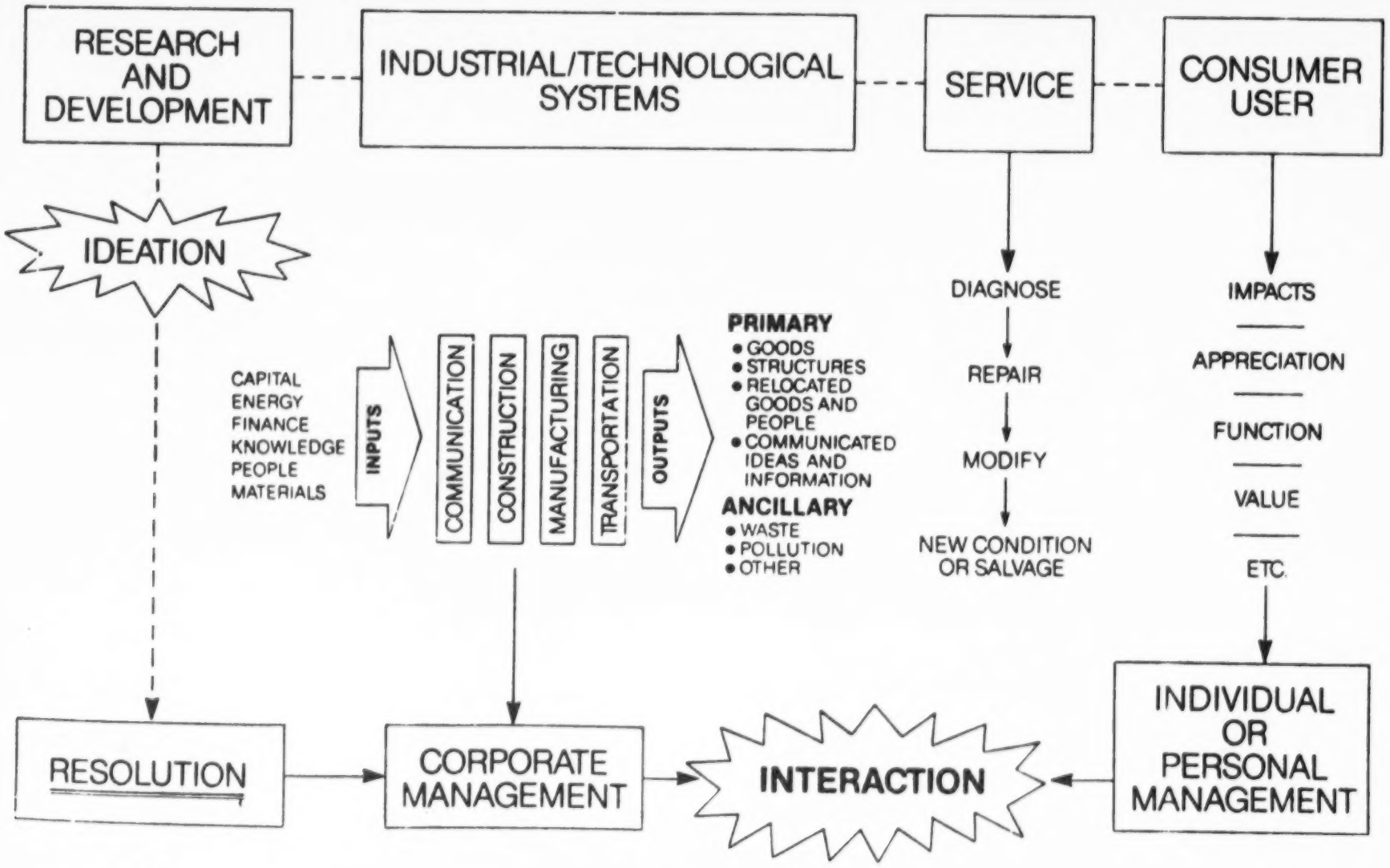
These often result in a managed productive system. Common to all four subsystems of a human technical endeavor are the following:

PRODUCTIVE PROCESSES: those activities designed by people which utilize selected inputs to reach desired goals.

MANAGERIAL PROCESSES: those activities designed by people to insure that productive processes are performed efficiently and appropriately.

MANAGED PRODUCTIVE SYSTEM: a system developed by people in which each step in the transformation of inputs to outputs is efficiently planned, organized, directed, and controlled with respect to company goals and in concert with society objectives.

The unique aspects of the four subsystems of human technical endeavor are presented in the following narratives, charts and diagrams.

APPENDIX C

HUMAN PRODUCTIVE ACTIVITY CYCLE